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Distributed Training for the Reserve Component: Remote Delivery Using Asynchronous Computer Conferencing

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This research was performed to evaluate the cost-effectiveness of using Asynchronous Computer Conferencing (ACC) and to develop guidelines for effectively conducting high-quality training using ACC. The evaluation used a portion of the Engineer Officer Advanced Course (EOAC). The same course materials presented in the resident course were developed for remote, asynchronous presentation. This delivery system was called the System for Managing Asynchronous Remote Training. The completion rate, performance, acceptability, and cost of remote presentation was compared to that of the resident program. The current state of Reserve Component (RC) training and the potential for remote training were described, as was previous research on remote learning. A summative evaluation was used to determine cost-effectiveness compared to resident training. A formative evaluation and literature review were used to develop guidelines for conducting ACC training.

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The summative findings were as follows: (1) ACC training costs less than resident; (2) there were no differences between resident ACC students on objective performance measures; (3) ACC students perceived a greater learning benefit than resident students; (4) ACC training had greater user acceptance, especially when group activities were implemented; and (5) resident training is superior to ACC training in both duration (i.e., resident training takes less time) and completion rate.

The formative findings were as follows: (1) deadlines and group activities were the most effective pacing aids; (2) group interaction motivated student participation; (3) 8 hours per week, covering all aspects of working on the course, is a reasonable student requirement; (4) immediate feedback is preferable to delayed feedback and the course structure should allow students to move ahead whenever practicable if feedback is delayed; and (5) support communications, such as a telephone hotline, are critical to the success of an ACC course.

This report provides guidelines for implementing ACC courses to maximize throughput, performance, and acceptance. It also presents evidence supporting the cost-effectiveness of ACC as a method of delivering remote training to the Army Reserve Components.

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Training and Simulation

FOREWORD

Limited time and wide geographical dispersion of both units and individuals in the National Guard and Army Reserve, i.e., the Reserve Component (RC), make it difficult and costly for soldiers to travel to branch schools for training. Therefore, the RC is exploring alternatives that will use technology to bring training and educational opportunities to the soldiers' homes. One of these alternatives is the creation of remotely conducted classes in which individuals are linked with each other and their instructors using asynchronous computer conferencing.

This report summarizes the findings on the effectiveness and costs of using asynchronous computer conferencing and makes recommendations for course design and teaching in the RC. The report was developed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Boise office within the charter of the Training Technology Field Activity, Gowen Field, whose mission is to improve Reserve Component Training effectiveness and efficiency through the testing and application of technology. The research task supporting this mission, "Application of Technology to Meet Reserve Component Needs," is organized under the "Training for Combat Effectiveness" program area. The National Guard Bureau, Forces Command, and Training and Doctrine Command Headquarters (TRADOC HQ) sponsored this project under the Memorandum of Understanding signed 12 June 1985 that established the office. Project results have been briefed to TRADOC HQ, Forces Command, Office of the Chief, Army Reserve, and the National Guard Bureau.

EDGAR M. JOHNSON
Technical Director

DISTRIBUTED TRAINING FOR THE RESERVE COMPONENT: REMOTE DELIVERY USING ASYNCHRONOUS COMPUTER CONFERENCING

EXECUTIVE SUMMARY

Research Requirements:

This report evaluates the cost-effectiveness of using Asynchronous Computer Conferencing (ACC) techniques to provide high quality, remotely delivered training to the U.S. Army Reserve Component (RC) and develops guidelines for effectively conducting such training.

Procedure:

The evaluation used a portion of the Engineer Officer Advanced Course (EOAC) as a test bed. Course materials that taught the same content presented in the resident course were developed for remote, asynchronous presentation. This delivery system was called the System for Managing Asynchronous Remote Training (SMART). The efficacy of remote presentation was compared to that of the resident program with regard to throughput, performance, acceptability, and cost.

The current state of RC training and the potential for remote training were described, as was previous research on remote learning. A summative evaluation was used to determine cost-effectiveness compared to resident training. A formative evaluation and literature review were used to develop guidelines for conducting ACC training.

Findings:

The summative findings were as follows:

1. ACC training was more cost-effective than resident training in that

   a. ACC performance (tests, homework, practical exercises) did not differ from resident performance;

   b. Costs for development and operation of an ACC course were less than operating a comparable resident course.

2. Comparisons of the amount students perceived they learned during the course showed that ACC students felt they learned more than did the resident students.

The formative findings were as follows:

1. The imposition of deadlines was the single most effective method of ensuring that students worked through the course at a desirable pace. The use of group activities also served as a pacing aid.

2. The availability of group interaction opportunities positively impacted students' motivation to participate in the course.

3. Students can be expected to spend 8 hours per week working on a SMART course. This 8 hours includes administrative time for activities such as interacting with the computer and organizing information.

4. Students preferred immediate feedback to delayed feedback. If feedback must be delayed, the course structure should permit students to move on to another assignment while awaiting feedback, wherever practical.

5. The availability of support communications, such as a telephone hot-line, is critical to the success of a SMART course.

Utilization of Findings:

This report presents evidence supporting the cost-effectiveness of ACC for providing remotely delivered training to the RC. It also provides guidelines for how such courses should be implemented to maximize throughput, performance, and acceptance.

DISTRIBUTED TRAINING FOR THE RESERVE COMPONENT: REMOTE DELIVERY USING ASYNCHRONOUS COMPUTER CONFERENCING

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DISTRIBUTED TRAINING FOR THE RESERVE COMPONENT: REMOTE DELIVERY USING ASYNCHRONOUS COMPUTER CONFERENCING

Introduction

Statement of the Problem

In its efforts to maintain overall readiness, the U.S. Army is faced with some unique challenges in training its two Reserve Components (RC), the Army Reserve and the Army National Guard. Training is a key aspect of readiness and, as described below, it is many times more difficult to adequately train the RC than it is to train the Active Army. The importance of a well trained RC cannot be overemphasized, for the RC makes up more than 50% of the total Army strength.

Background on Training the RC

Training is the responsibility of the unit commander, who may have many different military occupational specialties (MOS) to train. Typically, RC commanders have only 39 training days available each year distributed over 12 weekends and a two-week annual training session. In comparison, their Active Army counterparts train their units continuously throughout the training year.

RC units are scattered across the United States and overseas at more than 4,000 armories and reserve centers. As a result, there are large numbers of soldiers with low geographical density. Low density MOS often do not justify local courses, so travel to resident/branch schools is required. Resident schooling is commonly viewed as the best the Army has to offer, but training must accommodate civilian job and family responsibilities. Thus, a trip to the branch school may not be an acceptable alternative for many members of the RC.

Current RC Education Options

Usually, members of the RC complete course requirements through a combination of resident branch schools, such as the Engineer School, Reserve Forces (RF) schools, and the Army Correspondence Course Program (ACCP).

Resident training yields not only a high throughput (number of soldiers completing), but also high quality instruction. Eisley and Viner (1989) conducted a nationwide survey of RC opinions on training and reported that soldiers prefer resident classes to other training options because they are perceived as being of higher quality (i.e., as having good instructors, course content, and facilities). However, resident courses are not very accessible to the RC soldier, who must juggle job and family schedules to attend. Gaining attendance at resident school is more difficult than gaining attendance at other options (Eisley and Viner, 1989). Further, the cost to the Army, in terms of travel, per diem, and pay, is quite high. The cost per RC student for seven modules of the Engineer Officer Advanced Course (EOAC) is estimated by Training and Doctrine Command Headquarters to be $40.5K.

RF School training, on the other hand, sacrifices some quality control for greater availability and lower costs. RF school data indicate a per student cost of $3.3K for one phase of EOAC. RF courses tend to be easier to fit into civilian commitments. Eisley and Viner (1989) reported that soldiers favor RF schools with respect to ease of meeting schedules, class openings, and funding to support attendance. However, the quality of RF courses is not always consistent across locations, since maintaining a pool of qualified instructors is difficult for some MOS (Allen Corporation, 1986).

Correspondence courses, although readily available and low in cost ($48 per student for one phase of EOAC, Allen Corporation, 1986), have much lower throughput and quality of training than the other two alternatives. In many content areas, ACCP materials may not be doctrinally or technically correct, due to long revision cycles (Allen Corporation, 1986). Soldier acceptance of correspondence training is lower than acceptance of any other training option (Eisley and Viner, 1989). As a result, the dropout rate for correspondence courses is quite high, often exceeding 50% (Allen Corporation, 1986).

Purpose

An ideal training option for the RC would be one that minimizes cost and maximizes quality, throughput, and availability. High quality training that could be delivered to the soldier's home or armory/reserve center should provide good throughput and acceptance and meet the ideal if it were affordable. A potential method of providing such training is remotely delivered, computer-mediated training. The practical implications and cost-effectiveness of providing such training had been, however, largely unexplored.

The purpose of this project, then, was to investigate an innovative alternative to RC training: the System for Managing Asynchronous Remote Training (SMART). SMART is a distributed, computer-mediated training system capable of delivering training to soldiers' homes and/or armories/reserve centers. Of interest are the quality, acceptability, throughput, and cost of this system. Specific requirements were to (1) evaluate the cost-effectiveness of using Asynchronous Computer Conferencing (ACC) techniques to provide high quality, remotely delivered training to the RC; and (2) develop guidelines for conducting such training.

Overview of SMART

What is SMART?

SMART is a computerized distributed training system, the functions of which are to provide:

- -- communication,
- -- a combination of delivery media, and

-- course management

and the characteristics of which are to support:

-- geographically distributed training,
-- asynchronous and synchronous training, and
-- computer mediated training and communications.

As is illustrated in Figure 1, the SMART concept provides a communication system, allowing an instructor to communicate with students, students to communicate with the instructor, and students to communicate with each other, all in a distributed fashion. Each student and instructor has a personal computer that is networked through a host mainframe computer using existing telephone lines. Other names for this kind of communication include asynchronous computer conferencing (ACC) and computer-mediated communication (CMC).

The SMART concept also provides a combination of delivery media. All types of instruction, including paper-based materials, computer assisted instruction (CAI), storyboards (computerized slide presentation), formal and informal discussions, problem solving groups, peer tutoring, expert groups, practical exercises, simulations, video- and audio-tapes, interactive video disks (IVD), and hands-on activities, can be accessed via SMART.

Finally, the SMART concept provides a course management system, allowing the instructor to control and administer lessons, exercises, and tests, while maintaining rosters, grade books, and attendance records. SMART also provides mechanisms by which the instructor can provide feedback on the performance of various activities to soldiers.

The distributed nature of SMART means that geographically distant learners can participate in the instruction without the need to come together in one location. Students and instructional staff can be located anywhere there is access to a telephone. Students can work from their homes, armories, or reserve centers, and instructors can teach from branch schools, RF schools, or their homes. With portable computers, students and instructors can continue their participation in classes even when travelling.

Most of the instruction delivered via SMART is accessed asynchronously. That is, not everyone must participate at the same time. This flexibility of scheduling makes SMART quite adaptive to personal time constraints. However, it also means that there are built-in time delays before all students receive the instruction and that certain activities, such as group discussions, will take longer than they would in the face-to-face environment. When time delays are not practical, SMART allows for synchronous communication. Here, all students access SMART at one time and work together to accomplish a given task. When the task is completed, they return to the asynchronous mode.

Computerized means for soldiers and instructors to communicate asynchronously from distributed locations.

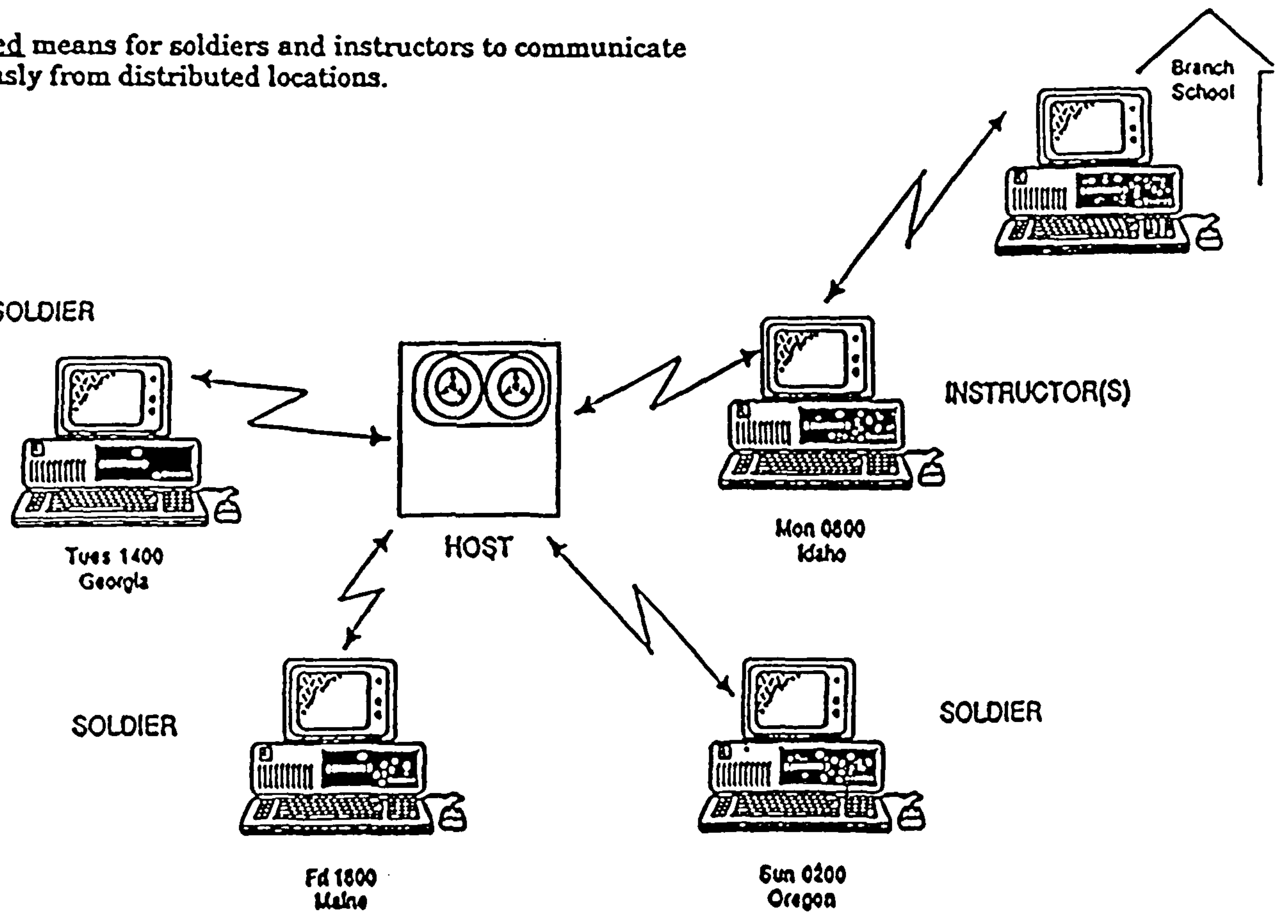


Figure 1. The SMART System

Because SMART is computer-mediated, it requires that each student have a computer with a modem, to enable computer communication over the telephone, and appropriate software to facilitate computer communication and learning activities. It also requires telephone links, a host computer which supports the uploading (transmitting to someone) and downloading (receiving from someone) of information, and a certain amount of learning on the part of the user. The system facilitates meaningful, connected discussions by a group of students. These discussions take place on their computers as students observe written input from each other and comment upon it. This distributed training system also allows instructors and schools to take advantage of the fact that every student has a computer, facilitating the use of computer-based training.

The Distributed Training Situation: Students and Instructors

As in some of the other distributed learning situations, such as correspondence, students learning via SMART are experiencing a tabletop learning environment -- they are likely to be sitting at the kitchen table or at a desk in their homes, working alone in the sense of not having other students physically present. Because they are in the RC, they are fitting their training around their daily routines and different students may be working on very different schedules. These factors combine to make the SMART learning experience quite different from that of a student taking a resident course. Figure 2 depicts segments of a "day in the life" of a resident student and a SMART student, highlighting differences between the two. Appendix A shows what the SMART student sees and does during a SMART computer session.

The fact that SMART is characterized by being distributed, asynchronous and synchronous, computer-mediated training and communication also impacts the SMART instructor with respect to both work schedule and duties performed. The emphasis on computer mediation and independent learning shifts the emphasis of the role of the instructor from primarily that of a deliverer of instruction to more of that of a facilitator and a counsellor. That is, the SMART instructor spends less time providing course content via lecturing or other classroom techniques than does the resident instructor and more time guiding students through the learning experience by directing their studies, answering questions, and providing performance feedback.

Figure 3 gives highlights of a "week in the life" of a SMART instructor. For the purposes of the illustration, it is assumed that the instructor works full time teaching one course. Note that, although the instructor works for 40 hours during the week, that time is allocated according to student needs rather than as an eight to five workday. Further, to ensure timely feedback, it is necessary for the instructor to check in on the computer on at least a daily basis.

Typical Day	Resident Student	SMART Student	Notes
0700	Wake up & take a shower	Drive to work	The resident student can devote the entire day to course work; the SMART student devotes more than a third of the day to civilian employment
0800	Report to the first class of the day	Arrive at the office & begin the work day	
0930	Take a break & chat with other students	Try to reach a classmate by phone; no luck	
0945	Begin a small group exercise	Get work assignment to write a major report by Friday	The resident student has face-to-face interaction with classmates so group exercises are accomplished quickly in a pre-scheduled time period; the SMART student must coordinate group work adding admin time to the activity
1145	Finish the group exercise; break for lunch	Classmate returns call; spends 20 minutes scheduling a synchronous meeting for Friday	
1300	Complete a CAI lesson at the computer lab	Eat lunch at desk while doing a SMART reading assignment	
1400	Go to lecture	Resume office work	
1700	Return to quarters	Drive back home	
1800	Have dinner with classmates	Have dinner with family	
1930	Do a homework assignment	Check kids' homework	
2040	Watch Monday night football	Work on SMART-- do a CAI and a paper-based exercise	Only after meeting civilian job & family requirements can the SMART student begin his or her studies
2330	Go to bed	Go to bed	

Figure 2. A day in the lives of a resident and a SMART student

SMART Instructor	Notes
<u>Monday</u> 0800-1100 Go online & receive messages & scores on activities, write replies & feedback & upload (download/upload) 1100-1500 Update records of soldiers' progress; phone students who have fallen behind 1500-1700 Take hotline call from a student having software problems; send new disks	Like their students instructors access SMART via the task list; they can see grades on lessons that are computer scored, pick up assignments to grade, post grades, receive questions & comments & post answers to them; students who are not getting online either because they have fallen behind or are having computer problems must be contacted by phone
<u>Tuesday</u> 0800-1000 Download/upload 1000-1100 Obtain clarification from proponent school on topic about which soldiers have questions	In SMART, the instructor has the opportunity to consult with experts or written resources before answering a question
<u>Wednesday</u> 0800-1100 Download/upload	
<u>Thursday</u> 0800-1200 Download/upload 1200-1600 Grade exams & homeworks	The time needed for downloading and uploading will vary by volume
<u>Friday</u> 0800-1100 Download/upload 1200-1400 Add funds to computer accounts 1800 Go online for synchronous meeting 1830-2200 All students are ready to begin the exercise; give the assignment & watch progress 2200-2300 Grade group assignment & put feedback online	SMART instructors do both class admin (grading, etc.) and computer admin tasks Synchronous activities must be scheduled around students' other activities & prompt feedback is critical in SMART
<u>Saturday</u> 0800-1100 Download/upload	
<u>Sunday</u> 0800-1100 Download/upload 1900-2100 Go online for office hours	To ensure timely turn-around instructors must be on the computer daily

Figure 3. A week in the life of a SMART instructor

Background

The literature was reviewed to determine those variables most likely to maximize throughput and quality (performance and acceptability) and to minimize cost in distributed training. Most of the literature describes public civilian education findings in what is commonly called "distance education." However, much of this literature is, nevertheless, applicable to military, distributed, asynchronous computer-mediated training. The following tables summarize the findings of that review. (See Wells, 1990, for the full review.)

In addition, a pilot test was conducted to determine the feasibility and logistics of remotely delivering a computer-mediated course for the RC, and to begin to identify the important throughput, quality, and cost issues. A brief description of this pilot test follows the literature summary.

Literature Review

Distance education is a worldwide phenomenon. Remote delivery of education is popular where students are geographically dispersed or rugged climate conditions prevail (for example, in Canada, Norway, and Sweden). Third world countries use distance education in an attempt to educate their people in the most economical way possible and developed nations, such as the United States, provide distance education to adults who cannot easily attend traditional universities because of geographic dispersion or heavy obligations to career and family. Thus, the principles of distance education are derived from a wide variety of applications, both academic and industrial.

While this summary examines variables affecting successful remote delivery of education in general, it also considers the effect of these variables on a special form of remote delivery, asynchronous computer conferencing (ACC). ACC is the computer communications medium on which SMART courses are based -- students in SMART courses communicate with one another and with the instructor via a computer conference. Thus, SMART is just a specialized form of distance education. Distance education principles should apply to SMART in the same fashion as they apply to other remotely delivered instruction.

This literature summary is presented in tabular form and is divided into three major sections. Table 1 addresses throughput, which concerns variables affecting dropout and rate of progress through a course, quality, the variables affecting outcomes such as level of performance and student acceptance, is discussed in Table 2. Finally, variables affecting cost are shown in Table 3. If a variable affects more than one of these categories, it is listed in each category.

Table 1

Variables Affecting Throughout

Finding	Implications	References
Student-to-student interaction decreases dropouts, thus enhancing completion rates; group interaction also facilitates student study rates.	Group interaction opportunities should be incorporated in course design.	Baath (1982); Pentz and Neil (1981)
Students with lower educational levels are more likely to drop out.	Educational level can be used to predict not only which students are likely to succeed, but also which students might need additional assistance to succeed.	Wells (1989); Woodley and Parlett (1983)
Personal contact with an instructor, whether student- or instructor-initiated, has a positive impact on throughput.	Course design should incorporate instructor-student interaction.	Coldeway, MacRury, and Spencer (1980); Woodley and Parlett (1983)
Course completion is positively related to prompt feedback by the instructor.	Course materials should be designed with type and frequency of feedback in mind.	Coldeway (1980); Rekkedal (1982)
The rate of assignment completion can help predict course completion; completion of assignments in the first one-third to one-half of the course is especially critical to dropout reduction.	To facilitate completion, increase the frequency and decrease the length of assignments.	Wong and Wong (1979); Woodley and Parlett (1983)
Increasing the variety of media lowers the dropout rate.	Use a full range of media to enhance throughput.	Pentz and Neil (1981); Woodley and Parlett (1983)

Table 1 (continued)

Finding	Implications	References
Student dropout is higher under conditions of individual rather than instructor pacing.	Externally set deadlines should be used in distance courses to facilitate completion.	Coldeway (1982); Morris, Surber, and Bijou (1978)
Larger class size can lead to less feedback, slower response times, and higher student attrition.	Twenty-five students is probably a reasonable class size, but this may vary as a function of media selection and course content.	Hiltz and Turoff (1978); Manock (1984); Woodley and Parlett (1983)

Table 2

Variables Affecting Quality (Performance and Acceptability)

Finding	Implications	References
With respect to student motivation: students using ACC reported trying to do a more thorough job on assignments because other students would have access to them; motivation plays a role in both user satisfaction and in acquisition and retention of information.	Motivation may be the most important variable in utilization of a computer conferencing system--even a well-designed system will not be used without positive motivation.	Baath (1982); Hiltz (1986); Kerr and Hiltz (1982); Mason (1988); Vallee, Johansen, Lipinski, Spangler, Wilson and Hardy (1975)
Ready access to a computer is almost a pre-requisite for successful performance in ACC; quality of access (quiet location, etc.) also impacts performance.	Each student should have a computer that can be set up in a convenient location.	Harasim (1986); Kirkwood (1988); Vallee, Johansen, Randolph, and Hastings (1974)
Learning skills and strategies impact performance; cognitive processing skills (i.e., logically connecting ideas) are more important than mechanical skills (i.e., memorization); students do not always use the materials as intended by the designer.	Instructional materials should be designed to encourage depth of processing; course designers should use methods to ensure that students proceed in the proper sequence.	Marton and Svensson (1982); Rumble and Keegan (1982)

Table 2 (continued)

Finding	Implications	References
The instructor can play a critical role in student performance; the role of the instructor in a distance environment should be facilitative rather than authoritarian; the optimal amount of instructor-student interaction is curvilinear: up to a point, user acceptance is facilitated by high instructor responsiveness, but too much instructor activity can lead to student resentment.	Instructors must adopt a facilitative role in ACC and must take care to not dominate the interaction; specialized instructor training which emphasizes the differences between distance and face-to-face training and which provides skills needed in the distance environment is needed.	Coldeway (1980); Holmberg (1981); Kerr and Hiltz (1982); Rekkedal (1982); Smith (1988)
Group interaction may enhance user acceptance, since adults prefer to learn from respected peers than from an authority figure.	Incorporate group activities to enhance student acceptance.	Harasim (1986)
Time requirements of 10 to 15 hours per week should be acceptable to most students, accommodating their job and family commitments.	Students should be required to spend a maximum of 10 hours per week on a course; course duration should be set accordingly.	Kaye (1981)
Self-pacing may result in some students being weeks behind others, with the result that they are not prepared to perform the most recent assignment.		Hiltz (1986)

Table 3

Variables Affecting Cost

Finding	Implications	References
Cost per student increases if more personalized feedback is provided.	Personalized feedback, although costly, enhances both feedback and performance.	Rumble (1988)
Development costs to produce high quality materials are high, and may exceed those for resident training; use of existing materials reduces costs, but rarely produces good self-instructional materials.	High quality materials enhance both student motivation and performance; materials should be produced specifically for the distance environment.	Rumble (1988)
Media selection will impact costs, with some media being cheaper to develop than others (i.e., a one-hour text assignment will cost less than a one-hour interactive video).	Use of a variety of media enhances throughput, so media selection should not be driven solely by cost.	Rumble (1988); Sparkes (1984)
The most cost-efficient distance education system is one with few courses and large class sizes and in which classes are not revised frequently.	Some MOSs may involve relatively few soldiers, making it difficult to achieve an economy of scale; doctrinal changes may require frequent updates.	Rumble (1988)

In summary, the research reported suggests that quality instructional design and responsive implementation (including instructor performance) may often override student constraints (like time pressure) which would otherwise lead to dropout (Woodley and Parlett, 1983). Thus, the primary responsibility for student retention and performance may rest with the quality of an institution's instructors, courses, and support services. Hence, a great deal of attention was devoted to these issues in the current project.

Pilot Project on Using SMART for Delivery of RC Training

Pilot research was conducted to determine whether SMART had enough potential for RC training to warrant more detailed investigation. Results of this project are reported here, since they served, in part, as the basis for the decisions made in the implementation test. (See Richards, Hahn, Phelps, Blackman and Schurman, 1989, for a complete report.)

The pilot project used Asynchronous Computer Conferencing (ACC) to augment Phase III of the U. S. Army Reserve Forces School version of the Engineer Officer Advanced Course (EOAC). The phase consisted of seven engineer subcourses offered through the Army Correspondence Course Program (ACCP). Topics included technical subjects such as soils Engineering and Military Bridges. Students in the pilot test used computers to communicate with the instructor and each other to discuss the content presented in the ACCP materials and additional requirements developed by the instructor. The experimental course ran from November 1986 to June 1987.

The course management function of SMART was limited primarily to providing feedback on online activities. This feedback, however, was certainly more rapid and frequent than that afforded by ACCP. Students were required to interact directly with the computer conference host computer; SMART did not automatically prepare data for uploading or sort downloaded data for them.

Research questions. The research questions addressed in the pilot project were specific and limited:

- Can the throughput and quality of Army correspondence courses be improved by the addition of ACC?

- What are the costs,logistical requirements, instructional and/or motivational methods (such as computer hardware/software and instruction methods) necessary for implementation of ACC for RC training?

The Throughput/Quality issue was examined by comparing two versions of Phase III, EOAC. In the control version, participants took the module via correspondence according to ACCP guidelines. In the experimental version, the ACCP materials were also presented, but they were augmented by ACC. The dependent measures for this comparison were the percent of students completing the course, the speed with which they completed (throughput), and student performance (quality).

To examine the Cost/Logistics/Implementation issues, the experimental version of the course was analyzed as a case study. The activities of the students and the instructor were documented with special attention to cost and logistic factors and to the results of several instructional and motivational manipulations used throughout the course.

Lessons learned from the pilot test. While many of the results relating to throughput and quality were not statistically significant, they did suggest that further investigation of computer delivery of RC training was warranted: more students completed the course and in less time and there was a promise of higher level of knowledge gained and retained with ACC than with ACCP alone. Specific conclusions were:

(1) The experimental group showed higher rates of completion (percentage of subcourses completed) throughout the class than did the control group;

(2) The experimental group also had a higher percentage of completion of the course as a whole than did the control group; of the original experimental group, 36% completed the course compared to 27% of the control group; of the starters in each group, 64% of the experimental group completed vs 54% for the control group;

(3) The experimental group students who completed the course did so earlier than the control group completers; there was a statistically significant difference between the groups on number of days required to complete the course; there was also a difference in the number who completed the course on time (by the planned deadline) for each group, as compared to those who finished by the final deadline; and

(4) The on-time finishers in the experimental group did better than the control group finishers on both post- and retention-tests; late finishers in the experimental group performed slightly better than the control group on the post-test and did better on the retention test; however, performance differences were not significant since ceiling effects were evident in the scores for both groups.

As shown in Table 4, costs for the computer-augmented course fall between those for correspondence and resident training. If this result is coupled with the improved throughput and quality (over correspondence) discussed previously, it appears that the question of ACC-mediated, remotely delivered training warrants further study.

Table 4

Cost Comparison for Correspondence, Correspondence plus ACC, RF School, and Resident School Training for Phase III of EOAC

Training Method	Cost per Soldier
Correspondence	$48
RF School	$3335
Correspondence plus ACC	$4195
Resident School	$11585

Data for non-ACC training provided by TRADOC Headquarters or the 1155th RF School.

The logistics and implementation issues considered dealt primarily with usability and acceptability of the ACC system. Most soldiers, regardless of previous experience, were able to set up and operate their computers. In general, soldiers in the experimental group liked using the computers. On a five-point scale, soldiers rated SMART presentation at 3.8, below the rating of 4.0 for resident school, but above the rating of 3.1 for correspondence courses alone. ACC was rated almost the same as RF Schools (3.8 vs 3.7, respectively).

Logistical lessons learned included:

(1) Keep both hardware and software as simple as possible; soldiers are not computer experts and problems in these areas will be extremely frustrating and may lead to dropouts;

(2) Support communications, such as a telephone hotline, to assist soldiers who are having difficulties are essential;

(3) Take into account travel, odd work schedules, and family plans of part-time students by allowing some flexibility in scheduling;

(4) Individually accomplished activities are more accommodating to personal schedules than are group activities;

(5) Time requirements must be reasonable for the part-time student;

(6) Conferencing must be an integral part of the course requirements, not a sideline to a course primarily conducted in some other fashion; and

(7) Participation should be integral to completion of course requirements; soldiers should be judged on the basis of completion of

learning activities (such as participating in a group exercise) rather than strictly on the number of comments entered.

Rationale

Based on the encouraging results of the pilot project, a more rigorous implementation test of SMART was conducted to study throughput, performance, acceptability, and cost of a SMART course. The general approach was to develop a "best shot" course, that is a course which was designed to maximize throughput, performance, and acceptability. The literature on remote training and distance education, general principles of instructional design, and experiences from the pilot project were used to determine the specific factors investigated within the course and to guide the course design.

Course design parameters were specified at the outset of the course, with no *a priori* intention to systematically alter them as the course progressed. However, since it is recognized that course effectiveness is largely governed by good course design, we did allow *formative* changes in these parameters as need dictated. These formative changes were documented as part of the "lessons learned" from the project.

Several independent variables (including group interaction, pacing, instructor characteristics, and type of course requirements) were systematically manipulated during the course. Again, formative changes were allowed as needed, to maximize success. (A full description of both the course design parameters and the independent variables is contained in the "Method" section.)

Because the results of the pilot project were encouraging and because a major effort, guided by established literature, went into the course design, we felt that SMART was ready for a summative test. However, it was also felt that learning to optimize course design was an important outcome of the project. Thus, formative analyses were also a valuable source of data to add to our knowledge base on course design for the distance learning environment.

Method

Participants

Students in the SMART class were recruited from a pool of soldiers who (1) needed to take Phase III of EOAC and (2) had already taken Phase I. All interested students who were available in the desired time frame were permitted to take the course.

Fourteen students began the course. These students were all Lieutenants and Captains and all had at least some college education (12 of the 14 were college graduates), although only about half majored in engineering. Their average age was 34, and only one was female.

The control group consisted of RC officers who took Module 6 of EOAC in residence at the Engineer School during fiscal years 1987, 1988, and 1989. Data on test (n=370), homework (n=171), and course culminating practical exercise performance (n=165) were collected and pre- and post-surveys were administered to a subset of the RC students (n=49).

Materials

Course Description

The course consisted of Module 6 of the Engineer Officer Advanced Course (EOAC) as it was taught by the USAES (U.S. Army Engineer School) in 1987-88. EOAC is a mid-level course (i.e., between senior service school and technical MOS training) for officers in the grades of lieutenant and captain. Engineer officers must complete EOAC before they can be promoted to major. It was felt that the participants in this group would be mature, be committed to the Reserve Components, and be more apt to have either personal computer experience or the ability to learn quickly to use computers. Additionally, since 68% of all Army engineers are in the RC, there was a clear potential benefit of enhancing RC training within the Branch.

Further, the Program of Instruction (POI) for EOAC includes a mix of technical and leadership objectives. There is a stated instructional goal for the development of group skills through small group instruction and group interaction, an ideal application of ACC.

When taught in residence, Module 6 of EOAC consists of a mix of classroom lectures, lead through practical exercises, computer-assisted instruction, small group instruction, and a culminating practical exercise. The module is taught over a two week period. Both RC and AC students participate in the class. In the time period during which data were collected for this project, 55% of all resident students were RC. However, the AC/RC mix in resident programs is highly variable, and depends on training budgets and slots available.

Nine topics were taught in Module 6:

-- Rear Operations

-- Airfield Damage Repair

-- Military Petroleum Pipelines

-- Allied Presentation (Australia)

-- Asphalt Production

-- Army Writing Program

-- Flexible Pavements

-- Roads and Airfields and

-- Bridging.

At the end of the module, a course culminating practical exercise is conducted. This exercise, which is referred to as a "capstone" by the Engineer School, is a group activity which requires students to integrate technical information learned throughout the module and to coordinate efforts to share limited resources. Thus, students are presented with a series of construction directives which require technical solutions to bridging, roads and airfields, and similar problems. Additionally, students are given a time frame over which their designs must be able to be implemented, and a list of personnel and equipment available to implement them. Group members must negotiate with one another for these resources so that both individual directives and the entire project can be completed within the stated schedule. The culmination of the exercise is a briefing to a field grade officer, in which design alternatives, scheduling constraints, and recommendations are presented.

Course Design

The Resident School structure and EOAC contact were adopted, as they were judged to be the best training the Army had to offer. Thus, materials from the resident course were adapted for use in the SMART environment. Procedures for accomplishing such an adaptation are fully discussed in "Recommendations for Course Development and Implementation of SMART Courses" (Hahn, Harbour, Schurman, Daveline, and Wells, 1990.)

Course design was guided by the literature and the results of our pilot project. Details of the course design parameters are given below.

Time requirements and course duration. Students were permitted to participate in the course only if they would agree to spend a minimum of eight hours per week. Total course duration was set to accommodate an eight hour per week schedule.

Class size. Class size was dictated by student availability. However, different types of activities were structured to involve different numbers of students. For example, all students participated in classroom discussions, but students were divided into groups of four to seven to work on group activities.

Course structure. The course was designed to minimize student anxiety by beginning with easy, short lessons. Generally, lesson activities were kept as short as possible. Often, several activities were used to cover the material presented in a single lecture at the resident course.

Variety of media. Several different media (including paper-based materials, CAIs, storyboards, video-tapes, spreadsheet exercises, and synchronous and asynchronous discussions) were used in the course. The main constraint imposed in media selection was that all media had to be suitable for in-home presentation.

Learning skills and strategies. A listing of the tasks and the sequence in which they should be completed were used to help assure that students used materials in their logical order. Further, structured tasks, notetaking aids, "mandatory" time on task, and frequent checks on understanding were used to increase cognitive processing.

Feedback. Many of the learning activities were designed to provide immediate feedback during or upon completion of the activity. For example, performance feedback was provided throughout CAI lessons. Paper-based activities and storyboards were usually followed by a computer-scored quiz. Some activities required instructor grading; instructors were required to provide 24 hour turnaround on grading these activities. Further, instructors were expected to address all student questions or comments within 24 hours.

Motivational strategies. A variety of motivational techniques were used in an attempt to enhance motivation during the course. These included:

(1) Providing feedback to students regarding their progress in the course. The instructor used a set of decision rules for determining how close to the schedule students were keeping. Students were given messages ranging in tone from "You're right on schedule. Keep up the good work" to "You're more than 25% behind. We need to write a 'contract' for you to catch up. If you don't catch up, you'll be dropped from the course."

(2) Offering bonus points for on-time completion of the course.

(3) Reducing the maximum point value for late assignments to 75 rather than 100 points.

(4) Posting an honor roll of each week's "best achievers."

(5) Providing feedback on participation in team projects. Students were shown how their participation in group exercises compared to that of other team members. Further, each team was shown how their team's performance compared to that of the other team.

(6) Implementing a buddy system in which two students were assigned as partners to assist one another throughout the course.

(7) Promising to send letters of commendation and/or appreciation from the Assistant Commandant of the USAES to students after course completion. The type of letter sent was determined by the student's course participation.

Instructor characteristics. If the Army were to implement SMART for RC training, it is possible that part-time members of the RC would be employed as instructors. Our pilot project experience, however, was only with a full-time instructor. Thus, we had no information as to whether and how well (in terms of the outcome measures) part-time instructors could be used in the SMART environment.

Hence, in the implementation test, both full-time and part-time instructors were used. Five Reserve Component officers were assigned as instructors. One of these was full-time and served as the primary instructor, backing up the other instructors as needed to ensure the quality of the instruction provided to the students. He had successfully completed the EOAC course and had prior experience with SMART as the instructor in the pilot project.

The other four instructors were assigned part-time in various capacities at different times during the course. The roles assigned included instructor, team leader, and course culminating practical exercise moderator. All instructors received 40 hours of training in SMART instruction prior to the beginning of the course.

Support communications. A free hotline was set up for the duration of the course. Students experiencing difficulties could call this hotline for help 24 hours a day. When the hotline was not staffed, messages were recorded and help was provided as soon as possible. Further, students had free telephone access to the primary instructor for the duration of the course. He provided help on hardware and software problems, course content, and personal difficulties.

Procedure

As is shown in Figure 4, the course was implemented in three phases. Several variables, including (1) group interaction opportunities (individual vs group instruction), (2) pacing (individual self-set schedule vs externally imposed group paced deadlines), and (3) type of course requirements (content orientation in both Phases 1 and 2 vs process orientation in Phase 3), were altered across these phases. Content oriented course materials are those which focus on the acquisition of topical material. Process oriented course materials are those which focus on the application of content knowledge, as in the course culminating practical exercise.

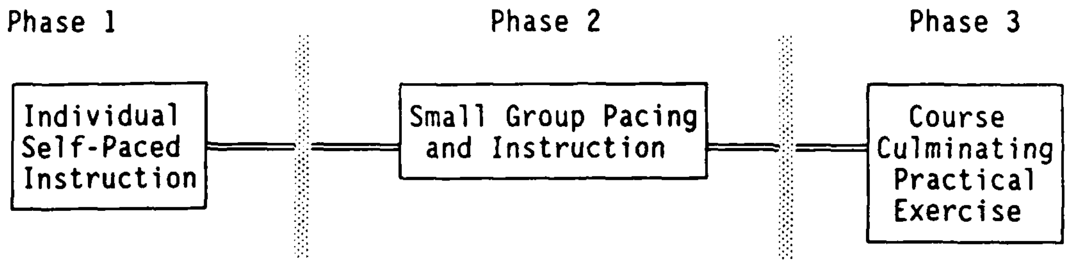


Figure 4. Three phases of SMART

Phase 1 had the following characteristics:

(1) all activities were designed to be completed individually, with no group interaction required;

(2) students were permitted to work at their own pace as long as they conformed to the minimum time requirements of the course; and

(3) course materials were content-oriented, teaching the following topics: Rear Operations, Airfield Damage Repair, Military Petroleum Pipelines, the Allied Presentation, and Asphalt Production.

The characteristics of Phase 2 were as follows:

(1) both individual and group activities were used;

(2) students were given a deadline for each topic; further, group activities required that students be up to date with their course work to participate, thus, serving as a pacing aid;

(3) course materials were content-oriented, teaching the Army Writing Program, Flexible Pavements, Roads and Airfields, and Bridging.

Phase 3, the course culminating practical exercise described previously, consisted of:

(1) a group activity with

(2) an externally imposed deadline and

(3) a process orientation.

The SMART software was tailored to the functional requirements of each phase. For example, in Phase 1, students were allowed to have social contact with one another in the break room, but content-oriented interactions were limited to those between the student and the instructor. In Phase 2, content-oriented interactions were unlimited. A full description of the software implementation for each phase can be found in Appendix B.

As shown in Table 5, summative data were collected during each phase of SMART. In addition, summative data were collected on Resident RC students who took EOAC during the time period that the SMART course was being developed and implemented.

Analysis and Results

Summative Findings

Two types of summative comparisons, external and internal, were conducted. External analyses compared throughput and performance data from the SMART test vs data from the Engineer School resident version of Module 6. Internal comparisons looked at throughput, performance, and acceptability (survey and interview) data collected in the two content-oriented phases of the SMART implementation test. Comparisons were also performed among the phases to determine the impact of group interaction, pacing and deadlines, and type of course requirements. Survey, interview, and online data were used in those comparisons.

External Comparisons

Throughput. Clearly, resident training is superior to SMART training with respect to both the duration of time needed for training and the percentage of students who complete the training. Completion of the equivalent amount of content material to that taught in our course is accomplished in two weeks at resident school. SMART administration took 31 weeks. Further, the drop-out rate at the resident school is quite low (5% or less).

Both phases of SMART training had a fairly large percentage of students complete training. Of the 14 students who started Phase 1, only one dropped, for a drop-out rate of 7%. In Phase 2, two of the starters, or 15%, dropped. Another two students stayed in the course for the entirety of Phase 2, but failed to take all of the exams required for course completion. Even counting these two students, though, 64% of those who started the course completed it.

Performance. Four types of performance comparisons were made between resident and SMART students. These included test performance, homework performance, course culminating practical exercise performance, and perceived skill ratings. Test performance was the most difficult of these comparisons because it was not possible to equate testing conditions for the two groups.

Students in the SMART course were given test questions pertinent to each subcourse immediately following each topic. These questions were the same as had been used in the resident end of course test at the time we began course conversion. However, by the time data collection began for resident school students, the resident course tests had been changed. The new test covered the same learning objectives as the previous test, but

Table 5

Summative Dependent Measures

Measure	How Collected	How Used
Course duration	Measured length of time needed to complete course for Resident vs SMART and length of time to complete each phase in SMART	Resident vs SMART comparison and Phase 1 vs Phase 2 comparison within SMART
% Completion	Measured number of students completing vs number of students starting	Resident vs SMART comparison
End of course test	SMART students completed a subcourse test at the end of each topic; Resident students were tested on all subcourses at the end of the module	Resident vs SMART comparison
Homework scores	Both SMART and Resident students completed homework assignments throughout the course	Resident vs SMART comparison
Course culminating practical exercise scores	Both SMART and Resident students completed a graded culminating practical exercise at the end of the module	Resident vs SMART comparison
Skill ratings	Both SMART and Resident students completed a pencil and paper survey of their perceived skill on each Module 6 topic before and after taking the course; pre-post comparisons indicated perceived learning	Resident vs SMART comparison and comparison of Phases 1 and 2 within SMART

Table 5 (continued)

Measure	How Collected	How Used
Scores on each activity	For SMART students, each learning activity was graded	Comparison of performance in Phase 1 vs Phase 2
Perceived acceptability	SMART student opinions on course acceptability were polled using a post-course survey, interviews, and comments placed online by students	Comparison of acceptability of Phase 1 vs Phase 2
Reasons for dropping	Survey administered to SMART students who dropped the course	As an indicator of acceptability
Perception of group interaction	SMART student opinions on group interaction were polled using a post-course survey, interviews, and comments placed online by students	Comparison of group vs individual learning
Type and content of online interactions	Online dialog was analyzed to determine the amount of student-student, student-instructor, and instructor-student dialog, and the content of those interactions	Comparison of interaction patterns given group vs individual learning modes in Phase 1 vs Phase 2 and content vs process orientation of Phase 2 vs Phase 3
Perception of pacing and deadlines	SMART student opinions on pacing and deadlines were polled using a post-course survey, interviews, and comments placed online by students	Comparison of individual self-pacing vs group external pacing

Table 5 (continued)

Measure	How Collected	How Used
Actual vs expected completion time	For each topic, a record was kept of when each student completed vs when completion was expected given an 8 hr work week or deadlines, as appropriate	Comparison of individual self-pacing vs group external pacing
Perception of content and process oriented activities	SMART student opinions on content and process oriented activities were polled using a post-course survey, interviews, and comments placed online by students	Comparison of content vs process learning activities

different questions were used. Hence, SMART subcourse scores and resident school end of course scores are similar with respect to the learning to testing interval (i.e., both are post-tests administered immediately following content presentation) but are dissimilar with respect to the specific questions asked. Because the questions on both exams do test the same learning objectives, however, this is probably the best comparison available.

Based on this comparison, there is no significant difference in the test performance of SMART and resident students (F (1, 377) = 1.80, $p < 0.18$). In fact, mean scores of the SMART students are higher (although not significantly so) than those of the resident students (91.96 vs 86.44).

Further, 100% of the SMART completers achieved passing scores on their criterion test on the first attempt; only 93% of the resident school students in our sample achieved a passing grade (70 or better) on their first try at the exam.

A multivariate analysis of variance was performed on the homework scores of the two groups. This MANOVA showed a marginally significant difference in performance of the two groups on their overall homework scores (Wilk's Lambda = 0.95, F = (4,175) 2.302, $p < 0.06$). However, univariate analyses of variance on the individual homework assignments showed no significant differences between the two groups. Table 6 shows mean homework scores for the two groups.

Course culminating practical exercise performance was also compared for the two groups. An analysis of variance was conducted, using the practical exercise scores as the measure of interest. No significant differences were found on the grades of the two groups, which averaged 90.44 and 89.99 for SMART and Resident School, respectively.

Both SMART and resident students also provided ratings of their skill level in the content areas both before and after taking the course. Pre-course skill ratings did not differ between the two groups.

Pre-post differences were analyzed to determine the perceived performance benefits of the two groups. A MANOVA performed on these

Table 6

Homework Scores

Topic	Resident Mean	SMART Mean
Flexible Pavements	91.73	83.33
Bridging	91.31	82.56
Roads and Airfields	95.78	89.70
Pipelines	95.39	88.33

difference scores was marginally significant (Wilks Lambda = 0.49, $F_{(15,28)} = 1.96$, $p < 0.06$). Univariate analyses of variance showed statistically significant differences between the two groups with respect to perceived performance benefits on rear operations ($F_{(1,42)} = 5.73$, $p < 0.0212$), airfield damage repair ($F_{(1,42)} = 13.40$, $p < 0.0007$), pipelines ($F_{(1,42)} = 4.69$, $p < 0.036$), flexible pavements ($F_{(1,42)} = 8.67$, $p < 0.0052$), and roads and airfields ($F_{(1,42)} = 15.42$, $p < 0.0003$). In all cases, SMART students perceived a greater learning benefit than resident school students. Table 7 shows means and standard deviations of the pre-post differences.

Table 7

Pre-post Differences on Skill Ratings

Content Area	Resident Mean (SD)	SMART Mean (SD)
Rear Operations	0.136 (1.13)	1.125 (0.64)
Airfield Damage Repair	0.409 (1.13)	1.875 (0.83)
Pipelines	0.452 (1.13)	1.500 (1.60)
Asphalt Production	1.250 (1.08)	1.875 (0.99)
Flexible Pavements	0.932 (1.07)	2.125 (0.99)
Bridging	0.500 (1.08)	0.625 (0.92)
Roads and Airfields	0.809 (0.99)	2.250 (1.17)

Note: Scores were obtained by subtracting pre-course ratings from post-course ratings. Ratings were based on a 1-5 scale.

Internal Comparisons

As explained in the "Procedure" section, the course was divided into 3 phases differing in type of pacing, group interaction, and content, the following analyses highlight differences found among those phases.

Throughput. With regard to the time required for completion, as compared to expected completion time, Phase 2 was clearly superior to Phase 1. Students took 1.2 times longer than expected to complete Phase 2 and 2.4 times longer than expected to complete Phase 1. As will be discussed subsequently, the use of deadlines is primarily responsible for the better course progress in Phase 2.

Performance. Table 8 shows the average scores on each graded activity throughout the course. Although it would appear that students performed better on the activities presented in Phase 1 than those presented in Phase 2, this is probably more a function of lesson content than any differences in the phases themselves. Bridging, on which scores were lowest, is generally considered to be the most difficult topic addressed in the course.

Table 8

Scores on Graded Activities

Activity	Mean Score	Standard Deviation
Phase 1		
Rear Operations Exam	96.67	5.00
Airfield Damage Repair Exam	97.78	6.67
Pipelines Homework	88.33	8.66
Pipelines Exam	94.78	8.69
Asphalt Production Exam	93.33	14.14
Phase 2		
Bridging Homework	82.56	27.58
Bridging Exam	83.56	10.29
Roads and Airfields Homework	95.78	3.46
Roads and Airfields Exam	98.56	2.24
Flexible Pavements Homework	83.33	9.35
Flexible Pavements Exam	88.33	13.31

Students provided self-ratings of their perceived learning. Prior to beginning the course, students rated their level of skill in each content area. After the course was completed, these ratings were repeated. The difference between the ratings was taken as an indicator of perceived learning benefit. Difference scores on Phase 1 topics were compared to those on Phase 2 topics. No significant difference was found in students' perception of learning benefits between the phases (t (54) = -0.2354, p < 0.82).

Acceptability. Based on post-course survey responses, interviews, and online comments, SMART students seemed to prefer Phase 2 over Phase 1 because of the group interaction opportunities it afforded. Students also expressed a preference for SMART training over that provided in correspondence or RF Schools. Some students even felt that SMART competed favorably with resident school.

Students who left the course were questioned about their reasons for dropping. Sixty seven percent cited personal reasons, such as family commitments or the need to complete the course in a certain time frame, as the reason that they dropped the course. Students who were dissatisfied with the course itself were generally concerned over the time commitment required, rather than technical aspects of the instruction.

Group interaction. A great deal of data was collected regarding the number and types of interactions which occurred in the individual activity mode (Phase 1) vs the group interaction mode (Phase 2). In general, interactive patterns changed between phases, reflecting the group emphasis in Phase 2. Further, students reported positive effects of group interaction. Detailed results follow.

Interaction patterns definitely differed between the phases. In Phase 1, communication between students was only allowed in the break room. As Figure 5 shows, however, even in this forum only 25% of the communication was between students. Most communication in the Phase occurred between a student and the instructor.

In Phase 2, student to student communication in the break room accounted for about 22% of the total traffic, similar to the proportion seen in Phase 1. However, this figure does not truly represent the amount of student to student communication that took place. As can be seen from Figure 6, in the team rooms nearly 60% of the interaction that took place occurred between students. The interaction patterns observed during Phase 2 make sense in light of the functions of the various rooms. The team rooms were set up as a place for groups of students to accomplish given tasks; conversely, the break room was an open forum for all speakers and the class room was oriented toward student/instructor interaction, since it was the place where students were to go to ask questions.

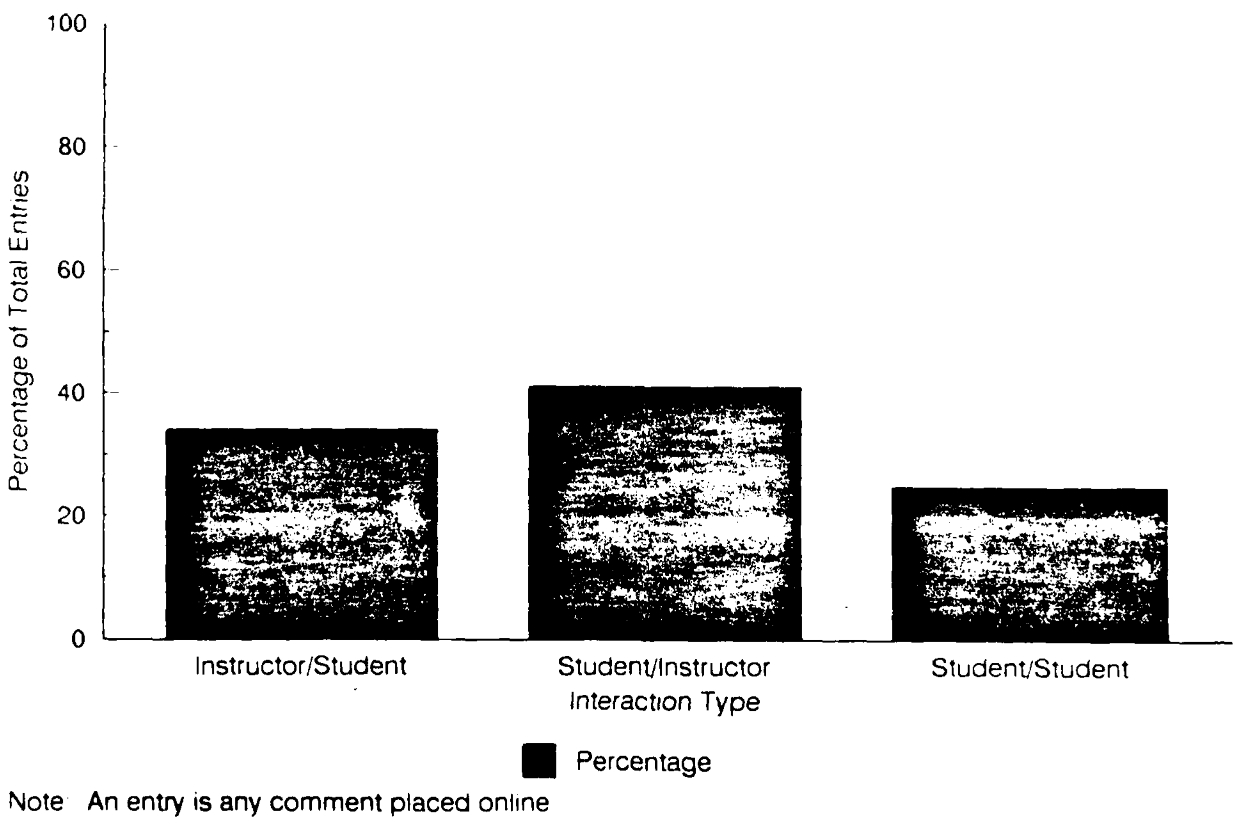
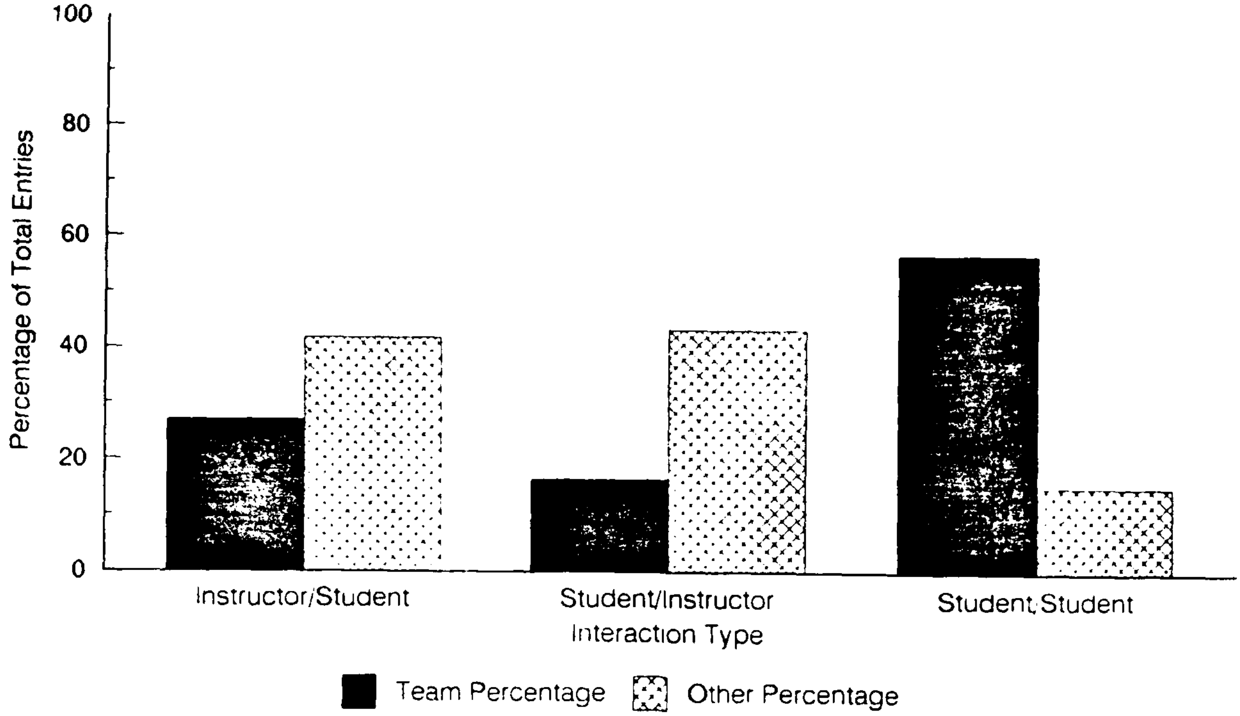


Figure 5. Types of interaction in break room communication during Phase 1 (n=132)



Note An entry is any comment placed online
Team percentage = team room entries; Other
percentage = entries in all other rooms

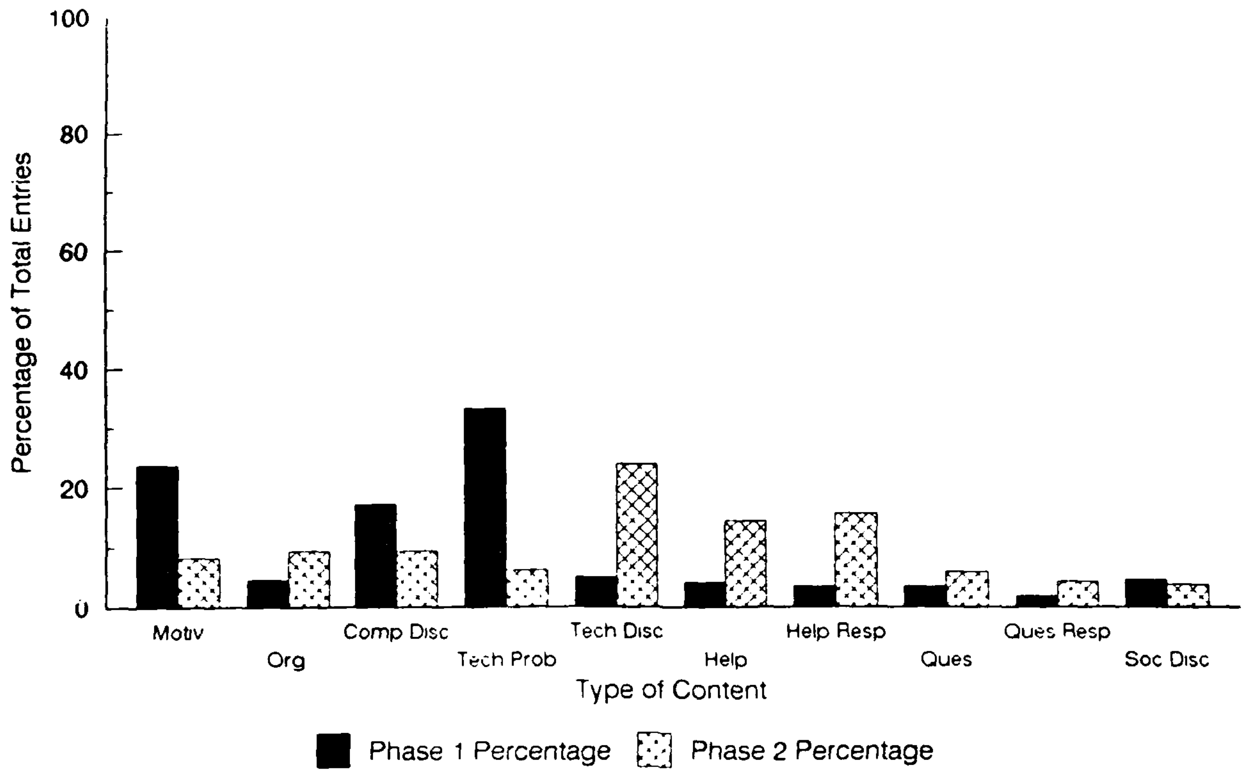
Figure 6. Types of interaction during Phase 2 (n=924 and 454 for team and other, respectively)

The content of the classroom interactions differed between Phases 1 and 2. Figure 7 shows the content of these interactions for the two phases. In Phase 1, the majority of the discussion centered around solving content-related technical problems, motivation, and computer questions and problems. In Phase 2, the emphasis shifted to technical discussion, requests for help on technical subjects, and responses to those requests.

These changes partially reflect the shift from individual to group emphasis between the phases. In Phase 1, students solved technical exercises on their own and discussed them with the instructor in the classroom. In Phase 2, technical exercises were usually conducted as a team effort; thus, the discussion surrounding the solutions to technical problems occurred in the team rooms.

Further, in Phase 1 the instructor worked with individual students to foster motivation. In Phase 2, emphasis was placed on "team spirit" as a motivator and motivational messages were more likely to be delivered in the team rooms than in the more individual-oriented classroom.

When students were asked about their preferences for group or individual work, 43% of the respondents said that they preferred team work,



Note: An entry is any comment placed online.

Figure 7. Content of classroom interactions for Phases 1 (n=206) and 2 (n=251)

while 29% said that they preferred individual work. Clearly, group activities are accepted favorably.

Further, all respondents either agreed or strongly agreed with the statement "Working in teams motivated me to participate in the class" attesting to the positive impact of group interaction on throughput. One student commented "Team work positively impacted motivation as compared to the individual section." Another said: "I'm enjoying the team exercises, and I'm learning faster and more thoroughly by being able to share everyone else's knowledge and expertise."

Pacing. Two different pacing issues were addressed simultaneously: the effects of using individual vs group activities as pacing aids and the effects of deadlines. General results were: (1) group activities require more calendar time for completion, thus, slowing the course; however, they also serve as a pacing aid, because students must be caught up with previous course work in order to participate; and (2) deadlines are effective in pacing students through the course. A detailed explanation of these results follows.

Individual activities can be completed in less calendar time than asynchronous group activities. The longest individual activity planned had an estimated duration of three hours. Based on the eight hour per week participation requirement, it was necessary to allot three days for completion of this assignment. Most individual activities were designed to be completed in one hour. These were scheduled to be completed in one calendar day.

Time estimates for asynchronous team assignments ranged from 0.5 to 1.5 hours. For asynchronous activities, however, teams were prompted to begin work at least one week before the deadline. One average, asynchronous activities took six days to complete.

Two synchronous activities, in which students were required to all work at the same time, were each scheduled to be completed in two hours (each activity was completed in one day). Actual completion time averaged 3.5 hours. While the synchronous activities were all completed in one calendar day, they did require substantial lead time so that students could set up a meeting time. On average, students began organizing synchronous activities nine days prior to their occurrence.

In spite of the fact that group activities slow the pace of the course in calendar time, they may also serve as a pacing aid. Students reported that they tried to be caught up on their individual activities so that they had the knowledge needed to contribute during group exercises: "Saturday morning I discovered our group project is due Sunday evening and Ken and I are responsible for Part 2. My conscience says I am not holding up my end of the bargain, so I have worked the entire exercise. Part 1 and 2 to follow. But first I had to work the first several parts of segment seven so that I may know what in the world is going on."

Very few other comments were made by students concerning pacing effects as a result of using individual vs group activities. A few comments were made, however, regarding pacing effects of asynchronous vs synchronous activities. Online comments showed a preference for synchronous activities since their use allowed students to gain quick closure on an activity then move on to something else. However, use of too many synchronous activities would result in too rigid a schedule.

The imposition of deadlines proved to be critical in keeping students working close to schedule. Figure 8 shows student progress through the course during Phase 1 when the course schedule was self-imposed. The "expected completion" line reflects the number of activities that should have been completed had students been spending eight hours per week on the course.

Progress was so poor, that a formative change was made part way through Phase 1 and deadlines were imposed. Figure 8 also shows that progress through Phase 1 improved once deadlines were set.

Figure 9 compares progress in Phases 1 and 2. The Phase 1 data reflect both the difference between the expected number of days for topic completion

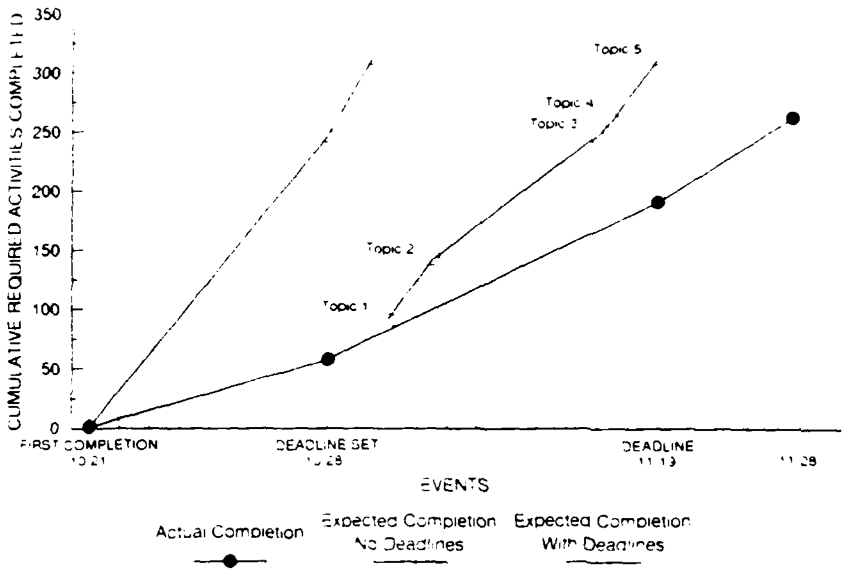


Figure 8. Course progress during Phase 1

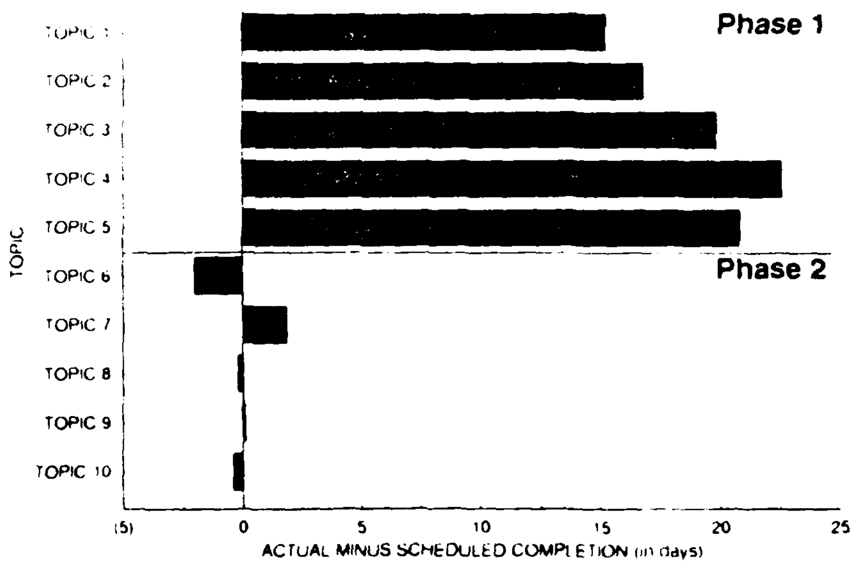


Figure 9. Course progress during Phase 1 vs Phase 2

if students were spending the required eight hours per week and the actual number of completion days. Based on the positive impact of imposing deadlines in Phase 1 demonstrated above, these data must be considered "best case" in comparing progress in Phases 1 and 2.

The Phase 2 data reflects the difference between the scheduled completion time given the deadline dates vs the actual completion time. Note how closely the schedule was adhered to under the deadline condition in Phase 2. In the worst case, Topic 7, students only missed the deadline by an average of two days.

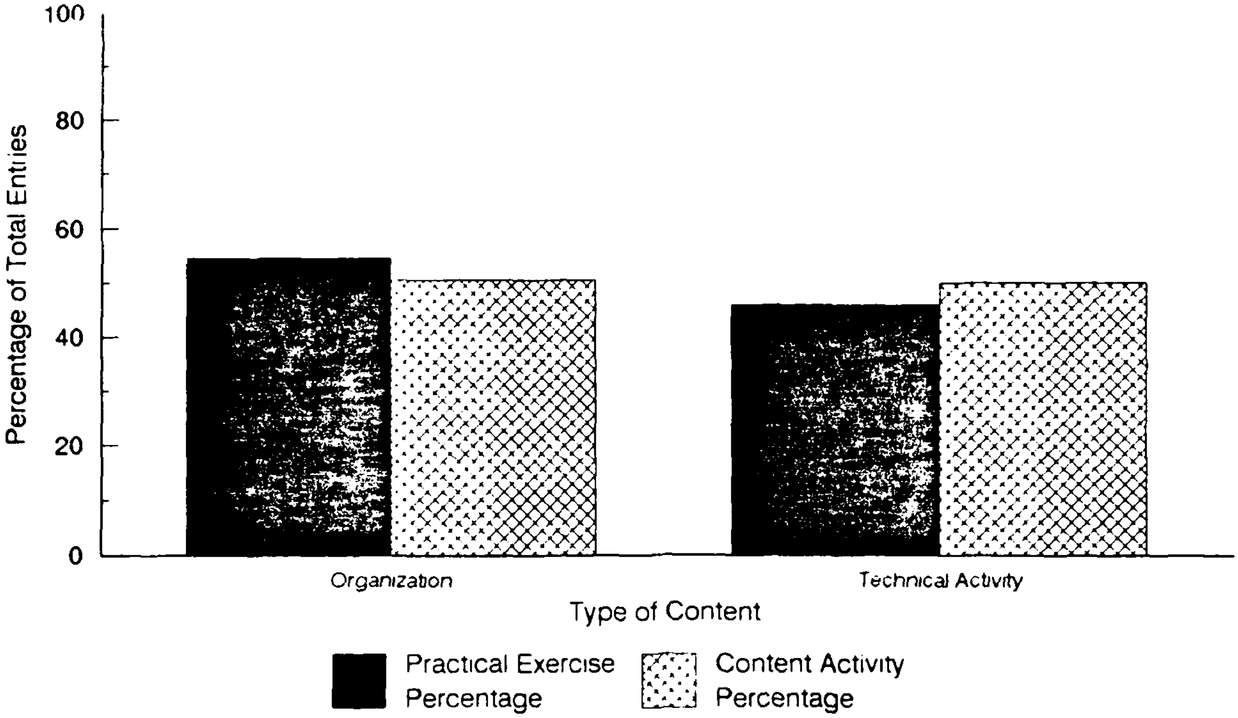
Students felt that deadlines helped them keep pace with the course and their acceptance of the deadlines was quite positive. One student commented "The best thing you did was to establish deadlines. Once you did that, I would log on night after night until I got there or got ahead, and then I would take time off, instead of spacing the thing out. My goal was to meet the requirement, and then take time to do personal stuff."

Type of course requirements. Based on a review of the online dialog, it is clear that the quality of performance was better on the content-oriented activities than on the course culminating practical exercise. Both teams got off to a very slow start on the practical exercise -- they spent a large amount of time talking about what they should do, rather than actually doing it. Further, both teams had periods of several days in which no one did anything! Although students could have been working offline, team members awaiting input from them were unaware of their progress.

Figure 10 shows the distribution of online entries dealing with technical content (things such as solutions to technical problems, technical discussions, and questions) vs those dealing with organization during the course culminating practical exercise and during other team activities (both synchronous and asynchronous). Data from the two teams were combined, since their interaction patterns were quite similar. Note that during the content activities, students spent about equal amounts of effort planning and performing activities. During the practical exercise, more effort was devoted to organization and less to actually performing the task.

Teams approached both the course culminating practical exercise and the content-oriented projects similarly, by having several (usually two) people working on the same parts of the problem, verifying each others' work. This method did not work well for the students in the practical exercise, however, because the teams were small in relation to the amount of work required. (See the discussion on class size for more information on this issue.)

Post-course surveys showed that 57% of the students did not feel that their content-oriented group activities prepared them to know how to interact during the practical exercise. Post-course interviews revealed that 83% of those surveyed did not understand the goals of the exercise.



Note An entry is any comment placed online.

Figure 10. Content of interactions during team activities (n=290) vs course culminating practical exercise (n=173)

They expected it to be focused on technical information, as the previous group activities had been, and did not expect the process orientation.

There is no clear cut information available for judging whether there is a difference in throughput, in terms of speed of completion, between content-oriented and process-oriented activities. Since the course culminating practical exercise was a much larger exercise than any of the content-oriented activities, it took quite a bit longer to complete. We have no quantitative basis for comparing content- and process-oriented activities of similar size. However, our feeling based on our observations is that process-oriented activities would take longer to complete because they require much more coordination among students, as evidenced by the increased organizational effort in the practical exercise. This coordination is very time consuming in a setting where the coordinator must often wait 24 hours or more before receiving an answer regarding the suitability of the plan being made.

In interviews, student reactions regarding throughput issues indicated that content-oriented activities had a positive impact on completion rate. Students were motivated to stay active in the course as a result of their participation in team activities.

The course culminating practical exercise, coming at the end of the module, had no effect on completion rate for the module. Students were of the opinion that they would complete this one last hurdle no matter how difficult. However, judging from the degree of burnout reported, it is unlikely that students would have wanted to begin another SMART phase immediately following this one. In this respect, the inclusion of culminating practical exercises at the end of some or all modules or phases may hurt student retention at the course level.

Based on online comments and interview data, students clearly found group content-oriented activities to be acceptable. Representative comments include: "You asked us to give our reaction on how we liked it [synchronous discussion]. If you don't mind a delayed reaction, let me just say that it was great" and "The most enjoyable part of the whole thing [the course] has been the five other folks on this team."

Comments on the course culminating practical exercise were not so positive. Many students complained that the workload during the practical exercise was too great and that the capstone briefing was a demoralizing experience due at least in part to their lack of knowledge of what was expected of them. Other students did feel that the practical exercise was or would have been a valuable learning experience if they had had some prior background in performing capstones and/or giving briefings.

Summary

SMART classes compare favorably with resident programs with respect to quality and acceptability, and are moderately successful with respect to throughput. Proper implementation of group interaction, pacing, and course requirements is essential to course success.

Formative Findings

Through observation of the course, we were able to learn a great deal about the impact of our choices regarding course implementation parameters. In most cases, the data gathered are purely informational and do not relate directly to the outcome measures. Where data are available regarding throughput, performance, or acceptability, however, they are noted as such.

Student Characteristics

No significant differences were found between the group of students which finished the course and the group which started but did not finish. Comparisons were based on demographic data, skills self-ratings, and opinions of training methods gathered on the pre-course surveys.

Drop-out surveys confirm that it was not because of lack of background or ability that students elected to leave the course. Rather, students mostly reported dropping out because the course did not meet their schedule needs or for personal reasons, such as changing jobs or having other commitments on their time.

Although the differences are non-significant, the survey data show a trend indicating that non-engineers may have had more difficulties with the course than did engineers. Among the finishers, all of the students had engineering-related Army jobs; only 40% of the non-finishers had Army jobs which were engineering-related. Similarly, the finishers had a larger percentage of engineering civilian jobs, engineering degrees, and computer expertise than the non-finishers. Again, however, the differences are not significant.

Comparisons were also made between the group of students which started the course and the group of students which received preliminary instruction about the course and completed the pre-course survey, but did not actually start the content-related learning activities. One interesting significant difference was found between the starters and the non-starters. The non-starters had a significantly more positive opinion of RF Schools than did the starters (Satterthwaite $\underline{t}$ (11.9) = 4.01, $\underline{p} < 0.0017$). Further, although their overall opinions of correspondence and resident courses did not differ significantly, the non-starters viewed some aspects of these courses more favorably than did the starters. Non-starters had a more positive opinion of correspondence with respect to increasing confidence as an officer and getting timely questions to answers than did starters. With respect to resident school, non-starters had a more favorable impression of building professional connections than did starters. This suggests that the non-starters may have perceived the availability of other attractive options for course completion.

Further, starters were more likely than non-starters ($\underline{t}$ (19) = -2.14, $\underline{p} < 0.05$) to report that they understood the learning contract given at the beginning of the course. This contract specified what was expected of course participants in terms of time commitment, number of online signons, and the like.

No other comparison between starters and non-starters yielded significant differences between the groups; however a marginally significant ($\underline{p} < 0.06$) result indicates that non-starters worked more hours of overtime per week than did starters. Hence, the non-starters may not have had time to participate in the course.

Time Requirements and Course Duration

As the course progressed, it became clear that students were not completing activities as quickly as we had anticipated. Initially, we thought that students were not keeping up with their eight hour per week time commitment. Online comments and discussions with soldiers, however, contradicted this belief. Rather, students reported spending, on average, 16 hours per week on the course.

When queried as to how their time was spent, students reported spending about eight hours per week on the learning activities and another eight hours per week performing administrative tasks such as uploading and downloading information and organizing their materials. We had not counted this overhead time in our time estimates.

Students found sixteen hours per week to be too high a workload: "We are going at a fast pace. It is too fast for me and I know how to do this stuff. I am currently on a 15 to 18 hour a week pace to keep up." They thought that a total commitment of eight hours a week would be reasonable: "I think the pace should be about eight hours a week for the whole thing for reserves because there are too many other activities going on, working and everything else."

In addition to the eight hour per week requirement, we also told the students that they must sign on to the computer at least twice per week. The eight hours, then, had to be distributed over at least two sessions. Students found this to be inadequate, and recommended more signons of shorter duration: "You must log on each day. Logging on twice per week is not enough. It seems too much water has flown past" and "At the beginning, I would do it [download and upload] once or twice a week. But I couldn't keep up unless I did it three or four times a week." This practice, however, will add to course duration, as there is a certain amount of administrative time associated with each log on.

In analyzing data concerned with completion times required for various types of learning activities, we found that our time estimates were more accurate for some activity types than for others (i.e., there seems to be less individual variability in time requirements for some types of activities).

As shown by the standard deviation data given in Figure 11, storyboards and videos, with their inherent pacing qualities, are more likely to be completed in the time estimated than are CAIs and reading assignments, in which different students may progress at various speeds through the same materials. Thus, the types of learning activities selected may have an impact on course duration.

Class Size

Surprisingly, students mentioned very little about class or team size, except to note the demise of a team member. Review of online dialog gives the strong impression that our teams were a good size for the content-oriented team activities (with at least five active members), but that they were too small for the course culminating practical exercise.

One capstone team had only four members participating. This meant that, in some cases, one person had several assignments and that there were no "spare bodies" available to verify the work of other team members. Even the student leaders, who really should have had mainly a coordinating role,

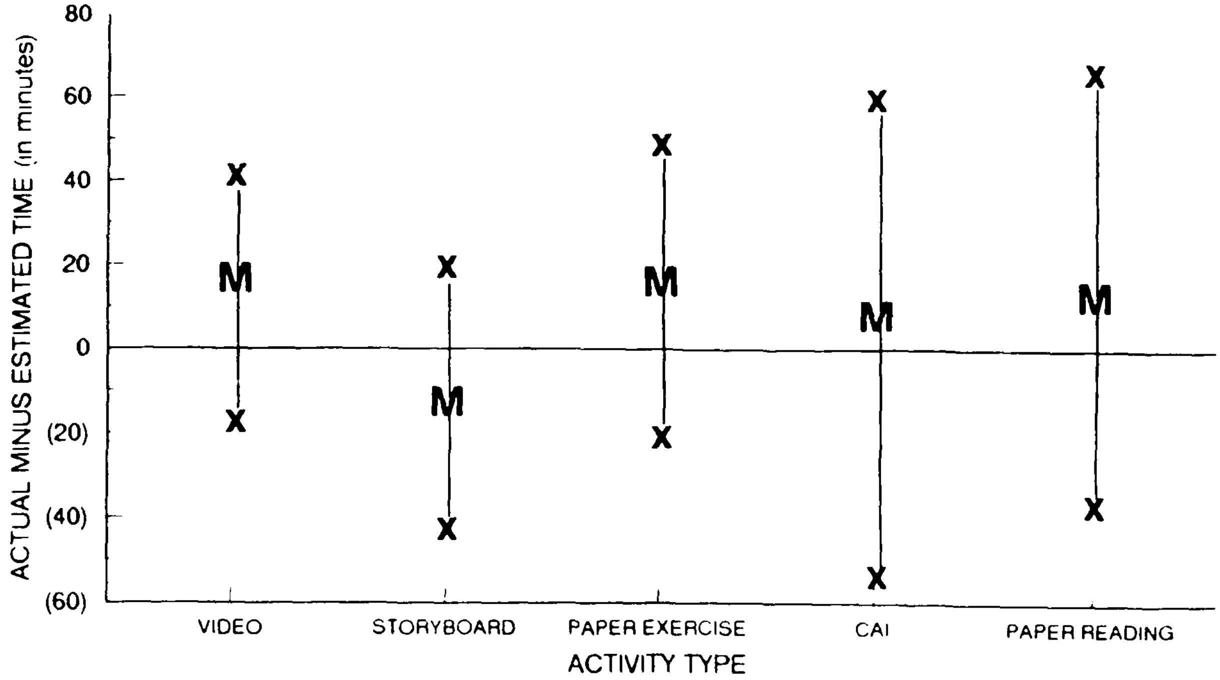


Figure 11. Means and standard deviations for the difference between estimated and actual completion times for different types of activities

got involved in technical work. At a minimum, it would seem that team composition for course culminating practical exercises should be: one student for each technical problem, one technical coordinator, and one student to check all work. In our case, then, at least six <u>active</u> members were needed.

One student's comment reflects this problem: "There was like four of us and we couldn't get enough people getting back on timely things so you just couldn't tell what was going on. Everyone said 'Yeah, I'm doing my job' and you didn't know if they were or not. You had too many things to put time into. Whenever we get into a group activity like that, if one person let's you down it really hurts." The difficulty in determining class or team size, then, is not one of determining sheer numbers, but, rather, of ensuring a minimum number of active participants. In our case, between one-quarter and one-third of team members did not participate fully in the course culminating practical exercise.

<u>Variety of Media</u>

Student comments revealed that there were almost as many opinions of the various media as there were soldiers. Two of the media selections, however, were universally disliked: reading assignments from TMs and FMs were perceived as boring and difficult; the combination of videotape and notetaking guide was disliked because of the need to constantly stop and start the film.

One other point about media arose from student comments: CAI packages must be selected so as to accommodate a wide range of answers, particularly if students are expected to read from nomographs and/or interpolate. The package we used allowed only four options for a correct answer. Consequently, students were being told that their answer was incorrect if it was not one of the four programmed possibilities. Sometimes, answers which were off by only .001 were marked wrong. Needless to say, this was very frustrating for the students: "If you didn't get exactly the number in the program the answer is wrong. For mathematical problems that's great, but my eyeballs are not calibrated exactly like someone else's and therefore I'm wrong. When you're talking about interpolating ten numbers within a 1/8 inch space I feel there should be a little bit of room on either side of your answers.

Finally, students appreciated the use of some paper and pencil exercises: "For some reason, I feel more comfortable with paper and pencil than putting my answers directly on the screen. I guess that the computer has something of a finality about it. But you can always erase the pencil." Student comments also stressed the need to ease into computer skills slowly, since the fear of the computer must be overcome: "I was very intimidated by the computer at first. Not being computer literate, I had to counter my fear of doing the wrong thing."

Following each individual learning activity, students filled out a short questionnaire on which they were asked about the contribution of the media selection to the ease or difficulty of learning. The majority of students felt that most media, with the exception of paper-based exercises, made the technical content easy to understand. For paper-based exercises, 41% of respondents said that they made the content easy to understand, 26% said that they made the technical content difficult to understand, and 33% had no opinion. For all other media, at least 55% of the respondents agreed that the media made the technical content easy to understand.

Learning Skills and Strategies

Comments online and in interviews indicate that students do not always read materials as thoroughly as was intended: "I would skim read a lot because of the time crunch so I know what manual to use. I know vaguely where things are but I didn't really read it in as technical detail as I could have or maybe should have."

Further, students were not always sure what points should receive the most emphasis: "It would be extremely helpful if the activity description included some guidance about what to look for and concentrate on.

Finally, students relied heavily on the online listing of SMART tasks and became very confused during the course culminating practical exercise when it was not present. Although students were mailed a written listing of tasks which detailed specific practical exercise activities for them to complete, they still reported that they did not know how to proceed. Students repeatedly had to be referred to the written instructions by the instructor. Thus, changing the format of the cognitive organizers proved to be problematic.

Feedback

We had set a requirement that instructors must provide feedback and answer all questions and comments within 24 hours. In Phase 1, it was only possible to track turnaround in days; 55% of student comments and questions were answered in one day. This figure is biased on the low side for two reasons: the instructor often had telephone contact with the students, and answered their questions on the phone prior to putting a response online; and the primary instructor waited for the part-time instructors to assume their responsibilities -- when they did not, and more than one day elapsed, he responded to the students.

In Phase 2, turnaround occurred within 24 hours in nearly 80% of the cases. As shown in Figure 12, most instructor responses occurred either within four hours of when the student posted the comment, reflecting mainly synchronous discussion during team activities and office hours (periods

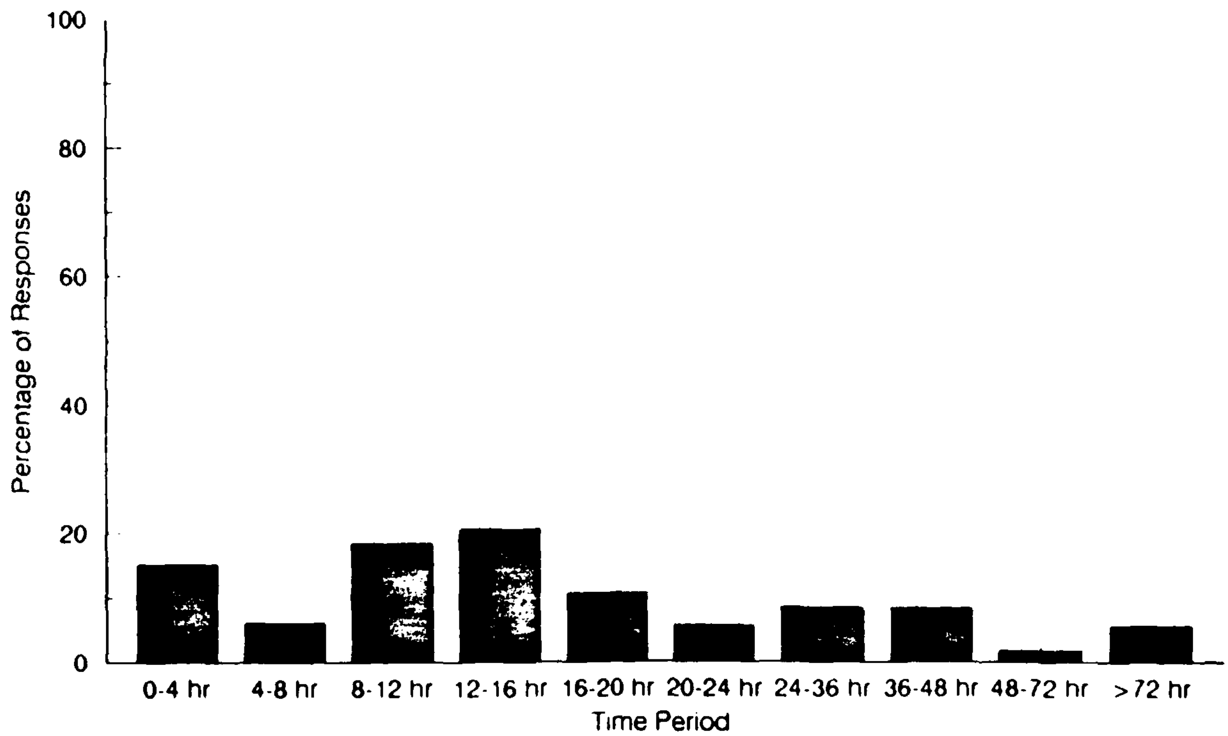


Figure 12. Turnaround time, in hours, during Phase 2 (n=243)

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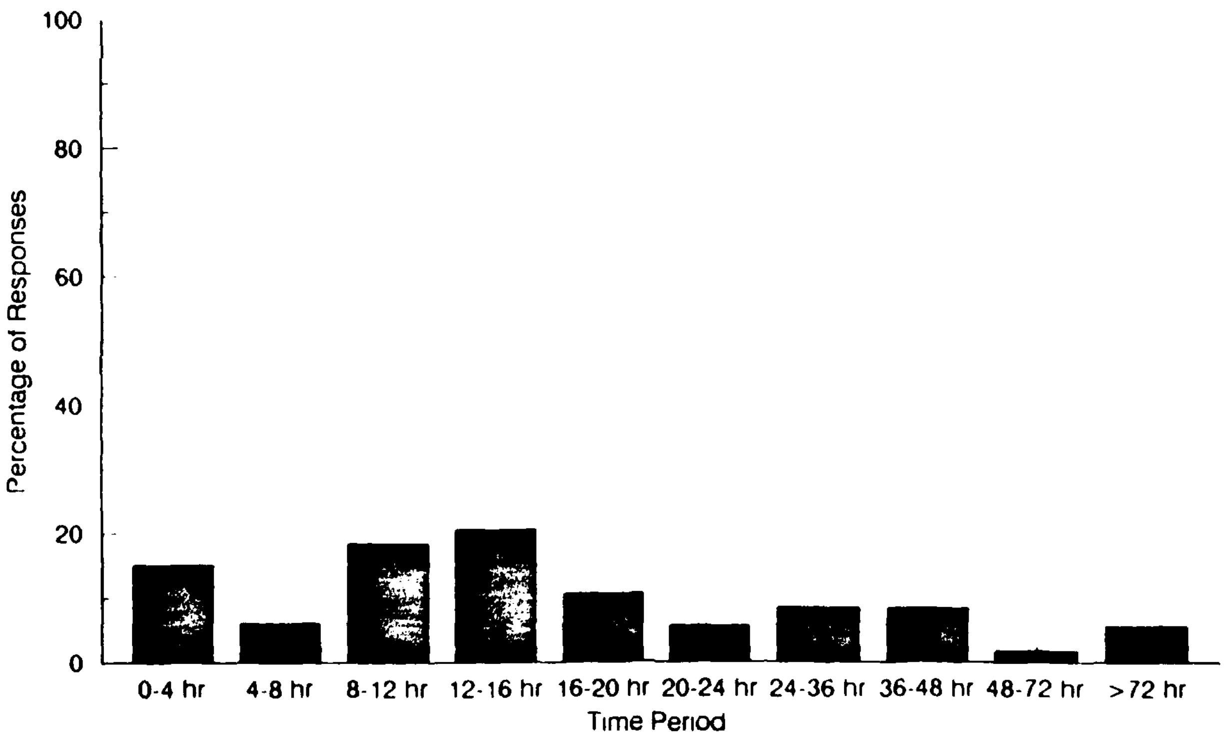

Figure 12. Turnaround time, in hours, during Phase 2 (n=243)

during which the instructor could be expected to be online), or in the eight to 16 hours post-comment time frame, reflecting that the primary instructor worked during the day while the students worked at night.

Student comments indicate that 24 hour turnaround is often too slow, especially when the student is working under time pressure and needs to wait for feedback to go on. This was a source of frustration for students, as indicated by the following comments: "When I would hit a snag, type up a message to an instructor or try to call, not being able to get an immediate response would shut me down for the night" and "I want to get done with this tonight and if I try to contact the instructor I will be waiting until tomorrow to get an answer. This is the delay in response that constantly occurs. I can't expect an instructor to be available all the time, but I can't wait to hear from him."

Obviously, delays in feedback hinder throughput in terms of rate of course completion. We had set up our course such that the receipt of feedback on a particular activity was a prerequisite for beginning the next activity. This caused delays for the students, who wanted to work for several hours in a sitting, but were unable to because they could not get feedback from the instructor until the next day. Students suggested that the specification of prerequisites be very limited in future SMART courses.

The quality of the feedback provided, however, was quite good, resembling the types of interaction one would expect to see in a face-to-face setting. The following is an example of part of a student-instructor dialog which took place during the course:

Student: "I have been working on this PLATO for going on six hours. I do not understand what is being explained to me. Rather than just getting further behind I'm going on. The calculations on V and M etc. is what I am talking about. Do you have any ideas on how I can better grasp this theory?"

Instructor: "If you can be more precise about what you don't understand it would be easier to help clarify the problem. The concepts of moment and shear involve how the forces act on the bridge. Moment always applies to a lever. It is defined as the force times the length of the lever arm. In order for a bridge to support a load it has to be strong enough to resist the bending moment. The 'section modulus' is a measure of a beam's ability to resist bending. A moment has to be calculated for each type of load, for the entire bridge, and on a per stringer basis. These values plus the allowable bending stress for the type of stringer allow you to calculate the required section modulus for the stringer. You then select a stringer with a section modulus larger than the calculated value..."

Student comments also revealed that media that offered immediate feedback were preferred: "I like the CAIs. The immediate feedback is great."

Quizzes, too, should provide detailed feedback. Our computer administered quizzes were designed to display the student's overall score, but did not indicate which answers were incorrect. (This was done so that quizzes could be administered more than once; after students completed contingency activities they were often referred back to the quiz.) Students who received poor grades on quizzes were uncertain as to whether they misunderstood the content or had data entry errors: "I am not sure I can believe a 65% on the quiz and after finishing the CAI I am even more certain that I was right. Unless I hit the wrong button. Could you please let me know which questions I missed and what the recorded answers were?"

Motivational Strategies

Review of the course dialog, surveys, interviews, online comments, and the opinions of the instructor served as the basis for assessing the motivational strategies.

Several of the motivational strategies proved to be quite effective. These included:

(1) Feedback on course progress: Providing feedback on course progress seemed to have a positive impact on students' motivation, especially in cases where the student had fallen behind. In several instances, students entered into a contract with the instructor to catch up with the course on a specified schedule. Students generally did make an effort to comply with these contracts.

(2) Maximum of 75 points for late papers: This incentive worked well in motivating students to get assignments done on time. Only one team assignment (out of 12) was late, and this was more a result of communication difficulties than lack of effort. (The team had the assignment finished, but failed to transmit it to the instructor as their "final" answer.)

    Post-survey responses showed overwhelming support for this method: 85.7% of respondents said that penalizing late assignments was an effective motivator.

    Thus, it would seem that penalizing late papers had a positive impact on throughput, keeping completion rate on target.

(3) Feedback on participation in team projects: The instructor felt that this technique was effective and caused students to participate more than they would have otherwise. Online comments support this idea. Students found team participation to be highly motivating and also used participation feedback statistics to guide their own inputs: "I felt that I had to be right at the top in participation in group projects or I was letting down the group."

On post-surveys, 100% of respondents said that team membership motivated them to participate. Further, 57.1% said that knowing their participation rate vs that of other team members was motivating.

In light of these findings, it is likely that team feedback enhanced completion rates. Teams with members who were not highly motivated to participate would probably not have been able to complete activities in a timely fashion. Performance may also have been impacted, since students knew that other team members would be reviewing their work.

<u>Instructor Characteristics</u>

The analysis of the appropriateness of using part-time vs full-time instructors for SMART courses must be based on a case study approach to our experiences during the course. There are so few quantitative data on the part-time instructors that numerically based comparison of the part- vs full-time instructors is generally unwarranted.

During Phase 1, we had assigned a part-time instructor to serve as the "team leader." This role involved counseling students who were having difficulties either with course content or personal problems. Only three online comments were recorded from this person during the phase. Student's comments to him went unanswered. Repeated phone calls and visits were made to the team leader to encourage him to accept his responsibilities. When these attempts failed, the formative decision was made to protect the quality of the students' experience with the team leader (a position we felt to be crucial) and the full-time instructor assumed the team leader's responsibilities for the remainder of Phase 1 and all of Phase 2.

Two other part-time people were assigned as instructors during Phases 1 and 2. Of these, one was unable to participate due to computer problems resulting from an irregular power supply. The full-time instructor assumed his duties.

The other part-time instructor worked out fairly well. He did competently respond to students' comments and questions and did assume the administrative duties of the instructor (i.e., grading) during the topics for which he was responsible. Unfortunately, students had become very reliant on the primary instructor, since he had been the person with whom they had had all their interactions up to that point. Hence, he continued to receive questions and phone calls on topics for which the part-timer was assigned as the instructor.

As a result of their experiences with the unreliability of the team leader and the part-time instructor who had power problems, student acceptance of the part-time instructors was quite poor. Students had the perception that only the full-time instructor could be depended upon: "I don't think the instructors participated enough. The only one I really have a feel for was Keith [the full time instructor]. The other ones [part time] didn't seem to get into it too much. A lot of times it was 'Here's your instructor' and that's it, so Keith had to pick up."

The use of a part-time instructor as the course culminating practical exercise moderator worked out reasonably well. The nature of the practical exercise briefing almost requires that the moderator not be someone with whom the students have developed comfortable rapport. Thus, the primary instructor would not have been suited for this position. The main disadvantage of using this particular part-timer in the capacity of practical exercise moderator was that he had not kept up very well with the content of the course or the use of the computer conferencing software. Hence, a good deal of coaching on our part on both technical content and computer use was needed as he participated in the briefing. This introduced many delays into the briefing and made the experience quite hectic for the researchers and the primary instructor.

A small amount of data was collected regarding the time of day during which the part- and full-time instructors worked on the course. These data are shown in Figure 13. Note that the part-time instructors worked on a schedule similar to that of the students -- most work was done at night. The full-time instructor worked mainly during the day. This pattern may have implications for throughput, in terms of the rate of course completion. The schedule used by the part-timers works quite well if the instructor and the student happen to be online at the same time; the student

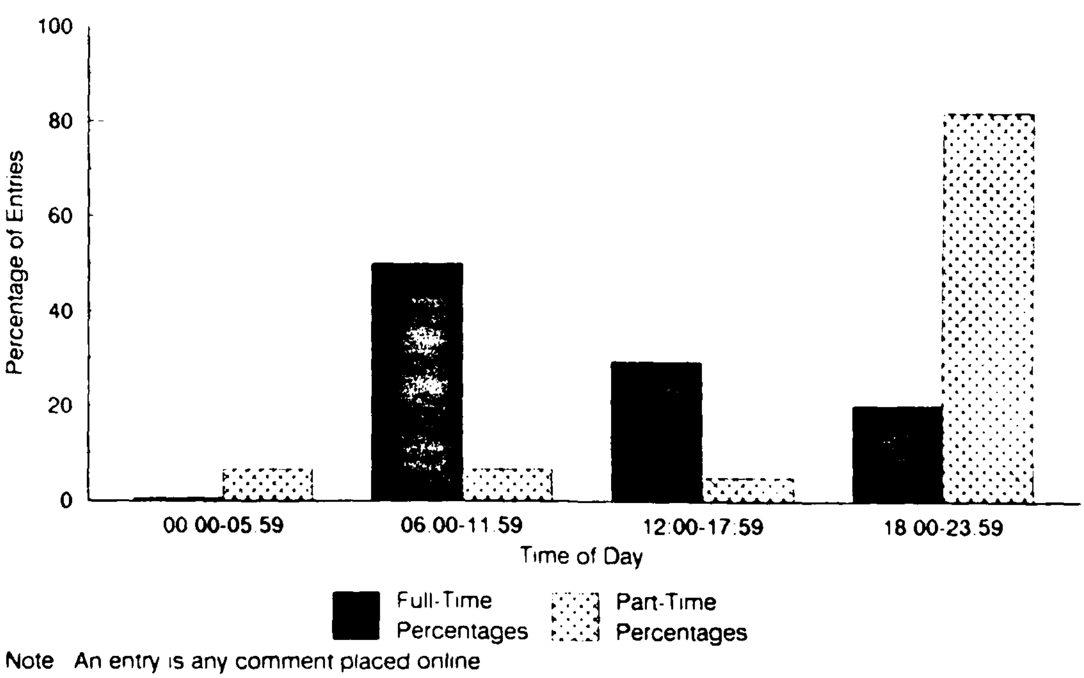

Figure 13. Online participation times of part-time (n=61) vs full-time instructors (n=212)

can get a question answered or obtain feedback and move on that same night. If the instructor and student do not "meet" online, however, turnaround time may be increased over that provided by the full-timer who can be online in the morning, answering questions from the previous night, and posting answers that will be available when the student signs online that evening. Certainly, consistency in turnaround will be greater with the full-timer, leading to a more reliable completion rate.

Support Communications

As shown in Figure 14, the primary instructor had a great deal of telephone communication with the students. Phone use was heaviest during Phase 1; during Phase 2, we encouraged students to communicate online students calling with questions that could be answered online were told to post them on the computer.

Early hotline calls to the instructor regarding hardware and software problems were quite heavy. Nearly 18% of all calls were placed in the first two weeks of the 31 week course.

Over the duration of the course, students placed 388 calls to the instructor. This averages out to about 30 calls per student. In comparison, students initiated 426 online communications with the instructor, or about 33 comments per student. Obviously, the telephone was a very important link to the instructor.

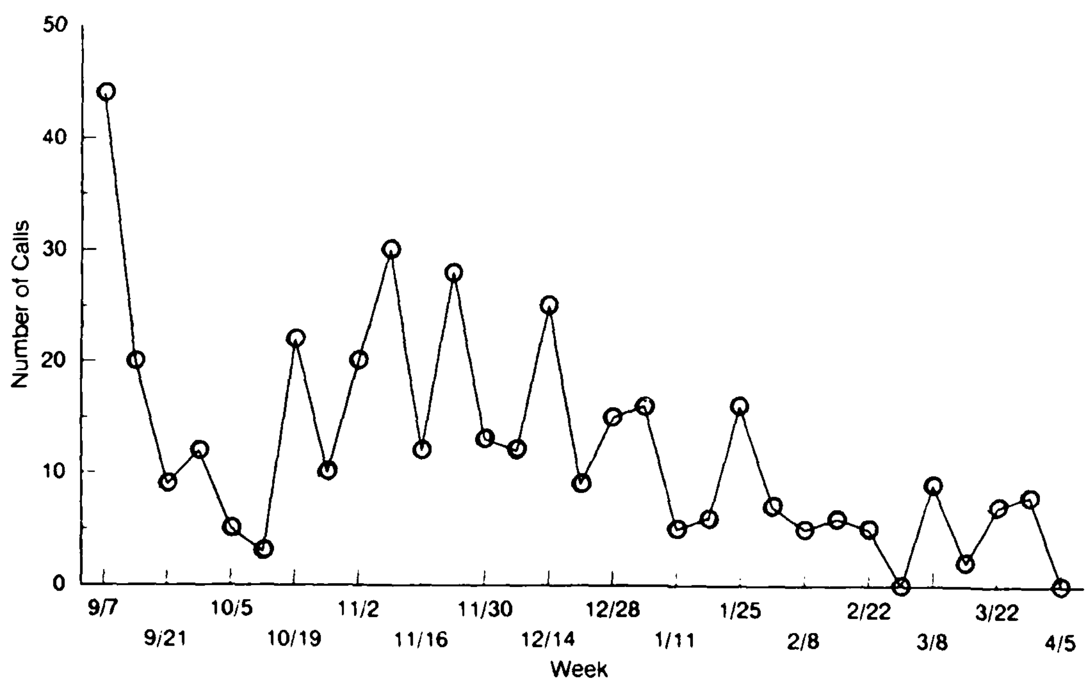

Figure 14. Calls to the instructor throughout the course

Although the hotline was equipped with an answering machine that would take messages in the evenings and on weekends (with someone returning the call as soon as possible), students noted that the hotline was not available when they needed it most. This caused delays in their ability to complete materials--often they had to wait a day or more to get a solution to a software or hardware problem that was preventing them from working on the course. Further, since calls were usually returned during the day, students were away from their computers and could not work through the problem solution while on the phone, introducing further delays if the solution did not work. Students appreciated having someone to help them during their hours of availability: "The hotline was generally available when you're not on the system because you're on the system late at night and on weekends. You guys have your regular office hours so if I have a problem at night I have to wait till the next day to go to work and call. Of course, it was 'What's the problem' and I'd go home and check. I guess it was Bob I ended up working with a lot. He ended up staying late in the evening which was super."

It was also noted that more telephone contact would have been helpful between students. In our course, we did not encourage such communication for several reasons. First, we wanted to maximize use of the computer conference both so that we could better observe student interactions and because that was the medium of interest in the research. Second, we wanted to minimize telephone costs and were afraid that students would not restrict their conversations to those which were necessary. Hence, while we did not ban telephone use, we did not encourage it. Most students did not call one another until during the course culminating practical exercise.

Students were of the opinion that telephone contact, especially early in the course, would have been helpful in building rapport: "More of a cohesion occurred when we got on the phone and discussed what was expected." Also, small points of coordination can be accomplished more efficiently on the phone than online, due to the inherent time delay of asynchronous communication: "I think that if you do this in the future you should make it clear to people that if they're going to coordinate little things using the phone works best."

Students expressed anxiety due to not knowing classmates and not being able to get a feel for them quickly online: "I think calling and talking voice to voice first would help, personal interaction. Then when you go to the computer you can do more. I felt funny because I didn't know these guys." In interviews, however, students were unsure of whether a face-to-face meeting at the very beginning of the course would be beneficial. They were afraid that the experience would be too short and that they would not have time to develop personal relationships. Several students mentioned the value of getting to know one another online first then having a face-to-face meeting to cement personal bonds prior to beginning a course culminating practical exercise.

Support communications other than telephone are necessary, especially in cases where students must turn in assignments involving graphics which are difficult to draw on a computer screen. US mail is probably the most economical route, however, use of the mail involves delays of perhaps as long as a week. This has a negative impact on the rate of course completion: "I have completed the homework but will not be able to go on to the next topic until you get it in the mail and grade it and post it...Can we speed it up a bit?"

Further, use of the mail may serve to shorten the time available to complete an activity, unless postmark date (rather than receipt date) is taken as proof that an assignment was completed on time. This may not be feasible if the instructor needs to have the materials available for viewing as the students participate in a related activity, such as a course culminating practical exercise briefing.

We also tried allowing students to transmit assignments via telefax to allow them the maximum time to complete activities while still having the work available for instructor review in a timely fashion. However, no students used this method. It is likely that the students did not have fax machines readily available to them. However, as this technology becomes increasingly available it should also become more appropriate for use in SMART.

Discussion

In this section, an overall evaluation of SMART in terms of throughput, performance, and acceptability will be provided. This evaluation will be taken from the viewpoint of what the Army could expect in terms of these outcome measures if they were to implement a SMART course. In addition, lessons learned from our experience will be noted. These should be helpful in improving future implementations.

Before beginning the evaluation of SMART, however, it is instructive to review how an Army implementation of a SMART course might look. For the purpose of illustration, we will show how the Engineer Officer Advanced Course for Reserve Components (EOAC-RC) would be implemented in SMART. EOAC is being used as an example only; the concepts discussed should generalize to any RC course.

What Would an Army Implementation of a SMART Course Look Like?

The following illustrates how the three phase Officer Advanced Course for Reserve Components (OAC-RC) could be implemented for Engineer branch officers in SMART. Currently, EOAC-RC consists of:

- Phase I (the Reserve Component Company Command Course). A two week phase in residence at the Engineer School (USAES), it is an intensive technical, tactical, and training management oriented course designed to provide a newly assigned or prospective company commander with the skills necessary to train and lead the unit.

- Phase IIA (common leader training). This phase may be taken through a Reserve Forces (RF) school, by correspondence, or as a four week (two module) session in residence at the USAES.

- Phase IIB (branch specific training). Usually taken by correspondence, it may also be taken by attending a four week (two module) session in residence at the USAES.

- Phase III (RF school resident training). Individuals will be tracked separately during Phase III based on unit of assignment. Those assigned to combat engineer units will take Phase IIIA while those assigned to combat heavy battalions or construction support companies will attend Phase IIIB. Individual Ready Reservists may choose either track. USAES resident training can be substituted for either phase, with IIIA requiring four weeks (two modules) and IIIB two weeks (one module).

SMART could be implemented at the course level such that EOAC-RC would be administered almost entirely through SMART. (Note - it is important to recognize that SMART can incorporate face-to-face instruction.) Figure 15 shows a SMART implementation structure.

(A) The Engineer School's Resident Company Command Course would be expanded by as much as two days to include face-to-face computer training to familiarize students with SMART methods and techniques prior to entering any computer-mediated phase. The familiarization would continue "remotely" via actual computer conferencing after the students' departure and before beginning another phase.

(B) Each of the remaining phases would be delivered using SMART and be broken down into two three month blocks. Students could sign up for the phases in any order, but would, once in a phase, take the blocks in a particular sequence. Students could elect to take as much as one month off between blocks, but would need to schedule breaks carefully so as to complete the entire course within the prescribed limit (perhaps 30 months rather than the current 24). One recommended exception would be that no time-off be allowed between Phase I and the next phase to minimize the decay of computer skills taught during Phase I.

(C) Topics within a block would be taken in sequence. Each topic might contain both individual and group work, with group activities normally occurring in parallel (rather than serially) with individual activities. Major group activities such as the EOAC "capstone" exercises, which serve as the culmination of a block or phase, could be placed at the end of the section where they would logically fit.

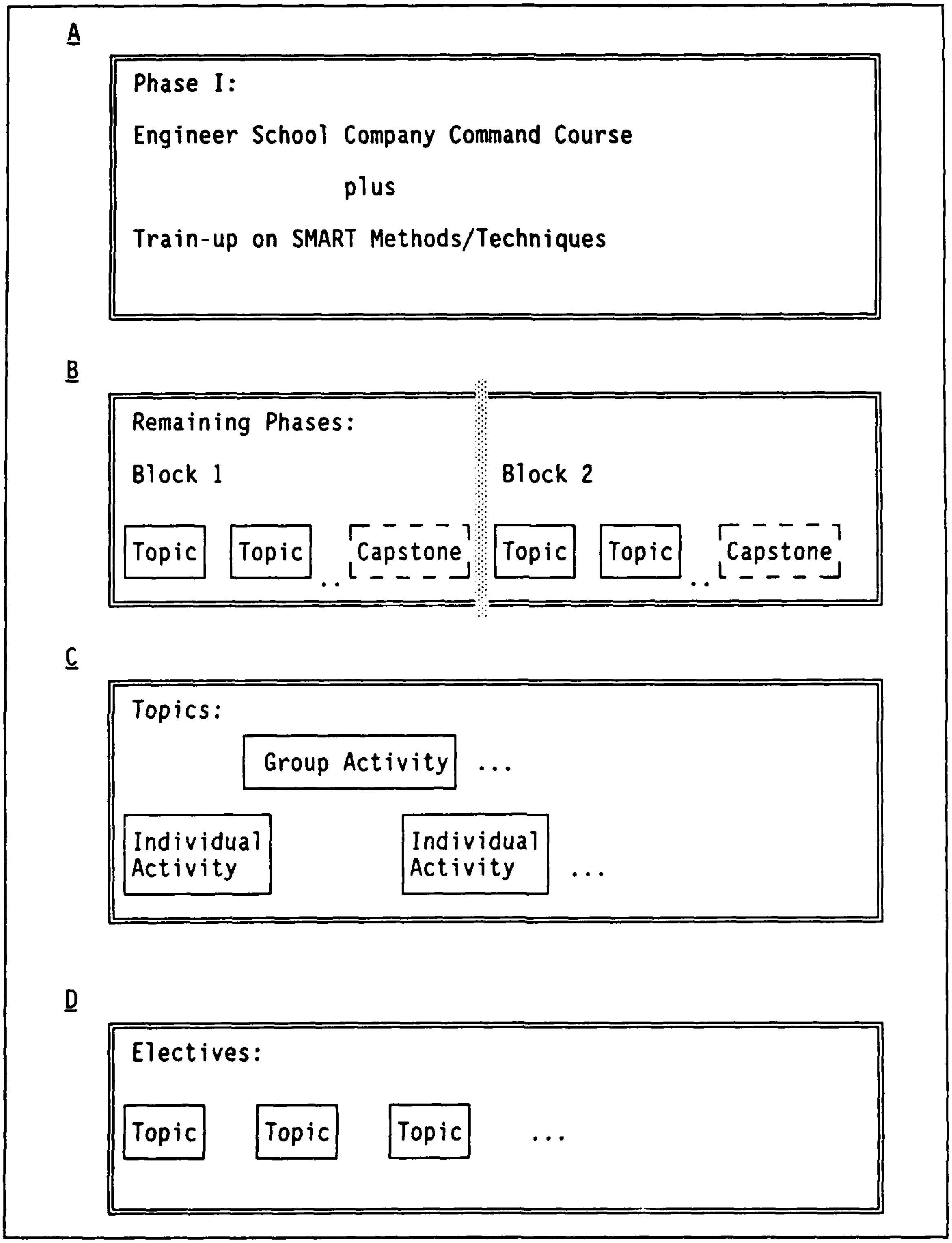

Figure 15. SMART implementation of OAC-RC

(D) Elective engineer topics offered by the USAES could be made available either at the time of enrollment or following the main course if students require additional/refresher training and have access to a computer.

In this implementation, a ceiling for class size could be determined from the number of students expected in the system at any given time. It may also be prudent to set a lower limit (e.g., 10 students) so that: (1) a "critical mass" is available for performing group activities and (2) each block can be taught in a cost effective manner.

Now, let us see what outcomes (throughput, performance, acceptability and cost) the Army could expect if it were to adopt a similar SMART implementation.

<u>Throughput</u>

SMART classes will take longer for students to complete than will the equivalent resident course. In our study, a two week resident course took seven months to present via SMART. In an Army implementation, we would expect students to be able to cover this material in about five months. Remember that we had additional time added to our schedule in Phase 1, because students were working at their own pace. Given that students will have deadlines in an Army implementation, and that some subjects (such as the Allied Presentation and perhaps the Army Writing Program) would be offered as electives, five months would be a reasonable completion time.

In our course, throughput, in terms of the percentage of students finishing, was inferior to that in resident programs. In resident school, 95% or more of those who start the course finish it. In our course, only 64% of the starters finished. This figure is probably the lower limit of what would be experienced in an Army implementation of SMART. Problems that plagued our course (such as software problems that were frustrating to novice computer users and the inaccurate estimate of the time commitment needed to complete the course) would not be present in a fully developed Army course.

The resident school does not have a problem with non-starters -- students who receive slots in resident school attend in all but the most extreme circumstances. The SMART course did have quite a few non-starters (33% of those who signed up). Again, however, in an Army implementation it is unlikely that the problem would be so severe. First, delays in software development that required postponing the start date of our course would not be expected in an Army implementation -- as was stated previously, this accounted for a majority of the decisions to drop the course prior to the start date. Also, our students had other alternatives for taking the course, namely, correspondence. If the Army were to implement SMART, these other alternatives might not be available.

Performance

SMART training provides the same quality of training as that found in resident school. When performance of SMART students on the most appropriate available data was compared to the performance of resident school students, no significant differences were found.

Unlike the comparison between performance of students in the pilot test with ACC students, this lack of a significant difference in test performance cannot be attributed to ceiling effects. Both SMART and Resident School test score data contained at least a 30 point range.

Finally, SMART students were significantly more confident of their learning in their skills assessment. SMART students perceived a greater learning benefit than did resident students.

Acceptability

In spite of the fact that students found the SMART course to be very demanding, they had positive opinions of it as a learning experience. Virtually all completers preferred SMART to correspondence. And, several of the completers compared SMART favorably with their resident experiences.

Even those students who still had a preference for resident courses praised the availability offered by SMART courses: "I like this system better than correspondence courses. It is fun to talk with others and get in to the humor in uniform (borrowed this from Reader's Digest). I also like to go to Belvoir or even Ft. Wood to take classes with others. But it was hard for me to get away more than once in a few years to two summer camps or not go to camp with the unit so that I could go to class. This is a good compromise."

Throughput, performance, and acceptability will be maximized only with careful attention to how the course is implemented. The following section documents the lessons we learned about course implementation.

Lessons Learned

We learned a great deal, both from the quantitative data collection and from observations of the impact of how we set course parameters. The purpose of this section is to note these lessons for incorporation into future implementations of SMART. Specific guidelines on the "how to's" of implementation are given in other documents produced by this project. These documents, and their contents, are described subsequently.

Group interaction. Based on findings reported in the literature that peer interaction contributes to high morale and positive learning experiences in remote training, it is reasonable to expect that courses which incorporate group learning activities in addition to individual activities would result in higher throughput and acceptability than courses based only on individual learning activities.

Although group activities have positive benefits in terms of pacing and enhancing student motivation, they reduce the students' ability to set their own schedule for task performance, reducing the SMART strength of flexibility. Thus, a mix of individual and group activities should be planned.

Further, all group activities should be planned to occur in parallel with individual activities, rather than serially. In this way, students will be able to continue to progress through the course even if they must wait for asynchronous communications from group members.

Pacing. Deadlines are indispensable for keeping students moving through a course. Deadlines must be set far enough apart to give students a reasonable amount of flexibility in the schedule they will set for accomplishing the objectives, but not so far apart as to encourage procrastination.

Group activities also serve as a valuable pacing aid. Students will try to be caught up so as to participate fully in these activities and not let their group members down. These types of assignments should be interspersed throughout the course, at intervals which facilitate flexibility of scheduling for the individual student.

Types of course requirements. Both content- and process-oriented activities can be conducted successfully via SMART. However, if process-oriented activities come at the end of a content-oriented course, as was the case with our course culminating practical exercise, special attention is required to ensure that students have the proper expectations regarding the activity. For the duration of our course, everything the students had been taught was "cookbook" and did not require integration on the students' part. Thus, a "cookbook norm" was established and the practical exercise, which required a great deal of integration, was totally out of character with what the students had been doing previously. Thus, a clear statement of the objectives of the exercises, as well as a description of how students should proceed in order to meet those objectives, are needed. Further, providing students a break down of the grading of each aspect of the exercise may be effective in helping them to place proper emphasis on the various exercise activities.

Further, careful consideration must be given as to whether or not students have learned everything needed to complete the exercise in earlier portions of the course. Specifically, consideration must be given to whether students have sufficient background in the process aspects of the exercise. For example, in our course students said that they did not know what was expected of them during the briefing portion of the exercise, since no other briefings had been given previously in the course. Hence, a dry run of the briefing would have helped prepare them with respect to the procedures expected.

Finally, student expectations must be properly set regarding the "tone" of the process-oriented activities, if it is different from what they have previously experienced in the course. Our students had had interactions with the instructor which were quite nurturing; thus, they were unpleasantly surprised when the briefing moderator was gruff and demanding. Students felt that this shift in tone detracted from the learning experience.

Student characteristics. Our experience reinforced the point that students in SMART classes are part-time students who have full-time jobs, family pressures, and other military duties. SMART classes will not be successful unless they are flexible enough to accommodate a variety of student schedules.

Time requirements and course duration. Students felt that a time commitment of eight hours per week would be a reasonable requirement, if that eight hours included course content as well as administrative tasks such as uploading and downloading. Careful estimation of the time required for both technical and administrative tasks is critical to course throughput, both in terms of rate of completion and numbers of completers. As has been previously stated, the extra time commitment needed to complete our course was one reason for attrition cited by students who dropped the course.

Class size. Short content-oriented activities can be accomplished by groups of five to seven students in a timely, learning-effective manner. Longer process-oriented activities require a larger number of participants -- a minimum of six students is needed for a practical exercise like the one we conducted. A group of ten to twelve students would not have been unreasonable for the exercise, as this would have allowed two students to work on each content-oriented problem contained in the exercise.

Further, in every class there will be a certain number of students who do not participate in group activities. In our class, one or two team members were "absent" from each group exercise. Hence, group composition must be set to help ensure that a critical mass of students is available for each activity.

Variety of media. With the exception of TM and FM readings, all media used in the course had both detractors and supporters. No strong preferences among the media were expressed. However, students did prefer media or combinations of media (such as a paper-based lesson followed by a computer scored quiz) which provided immediate feedback over those which required instructor grading.

Students also liked group activities, particularly those that occurred in the synchronous mode.

Learning skills and strategies. The primary lesson here is that students become very reliant on the cognitive organizers provided for them in the course. When we shifted the type of organizer (e.g., from computer-based to paper-based), students became confused -- they did not use the paper-based organizers provided for the practical exercise since they had become so accustomed to having tasks listed for them on the computer. Thus, organizers provided to the students must be consistent throughout the course and must also be very specific with respect to what is required of students.

Also, because the primary source of student anxiety revolves around unfamiliarity with the computer and lack of computer skills, courses should be designed to build computer skills incrementally.

Feedback. Students preferred to have immediate feedback on learning activities. The need to wait 24 hours for feedback on some activities was very frustrating. However, this problem could be ameliorated by allowing students to continue on to other activities while awaiting feedback. Also, the availability of support communications to quickly solve problems is critical.

Given the asynchronous nature of computer communications, and the fact that RC students are likely to only work on the course in the evenings or on weekends, it is probably not realistic to expect turnaround to occur in less than 24 hours. Setting the instructor's work schedule such that most online work is done in the mornings is adaptive in meeting a 24 hour turnaround goal -- replies to the previous night's questions and comments can be waiting for students when they log on that evening. However, some instructor time must also be made available during the hours when students are most likely to be online. Evening and weekend online "office hours" may help meet this need.

Motivational strategies. Of the motivational techniques we tried, the most successful were having a penalty for turning assignments in late and providing feedback about team participation. We recommend that these strategies be employed in other SMART implementations. Penalties for late assignments should be in conformance with the policy of the appropriate resident school.

Instructor characteristics. As was previously noted, we had very mixed success with our part-time instructors. However, our experience does not provide enough data to recommend for or against using part-timers. Rather, more research is needed into this issue. If the Army were to use part-timers, they would have far more leverage for ensuring that the instructors met their commitment than was available to us. In these more constrained circumstances, the use of part-timers might be more successful.

Support communications. The availability of other means to communicate with the instructor (i.e., telephone) is critical. Telephone communication provides a faster way to solve student problems than online communication, and may assist students in meeting tight deadlines. Even more important is that fact that students experiencing computer difficulties may be unable to communicate online. These students need an alternative means of reaching the instructor for help.

Students also expressed concern over not knowing their classmates. Getting to know one another online takes a considerable amount of time. Telephone contact in the beginning of the course can speed this process. Opinions on the value of face-to-face meetings at the beginning of the course were mixed. Unless such face-to-face meetings are long enough for students to really get to know one another, the expense is probably not warranted.

Like online interactions with the instructor, support communications must be available during the times when students most need them (i.e., evenings and weekends). This is particularly critical for students having computer problems, as they need to be able to call for help when they have ready access to their machine so they can be "walked through" potential solutions.

It is also helpful to provide means of transmitting graphic data that cannot be typed on a computer screen. US mail and fax service can meet this need.

As was mentioned previously, these lessons learned are provided to sensitize readers to issues that they need to consider to implement a SMART course. Specific guidance on the "how to's" of implementation is provided in two other documents generated by this project. These are described below.

<u>Guidance Documents</u>

<u>Distributed Training for the Reserve Component: Instructor Handbook for Computer Conferencing</u> (Harbour, Daveline, Schurman, Richards, Hahn, and Wells, 1990). This document is a job aid for instructors, trainers, and other key personnel working in a SMART environment. It provides general information about the SMART environment, the role of the SMART instructor, characteristics of adult learners, principles of learning, and information on the identification of high risk students. In addition, "how to" information on establishing class norms, group learning techniques, individual instructional techniques, student motivation, online etiquette, and course preparation is given. Finally, troubleshooting guidance on hardware and software problems, the SMART environment itself, group and individual instruction, normal class operations, and common student problems are discussed.

<u>Distributed Training for the Reserve Component: Course Conversion and Implementation Guidelines</u> (Hahn, Harbour, Schurman, Daveline, and Wells, 1990). This document is intended to provide principles and context for course developers and managers for developing and managing SMART courses in

accordance with the SAT (Systems Approach to Training) process. It provides recommendations for the analysis, design, and development of SMART courses and notes additions to or special considerations in the SAT process for SMART course development. In addition, recommendations for implementation of SMART courses are given with respect to: (1) when to use SMART courses; (2) who should use SMART courses -- instructor and student requirements; and (3) how SMART courses should be implemented with respect to technological, pedagogical, and administrative considerations.

Cost Analysis for SMART Implementation

In previous sections of this report, it was demonstrated that SMART is an effective training method with respect to throughput, performance, and acceptability. However, effectiveness alone will not form the basis for a decision as to whether or not to implement a SMART program. Cost, too, must be considered. This section reports on two cost analyses: (1) what costs would be expected if the Army were to implement SMART; and (2) the cost-effectiveness of SMART compared to resident training.

Implementation Costs

In determining costs for an Army implementation effort, costs were extrapolated from our actual experience and were based on the assumption that the phases of the implementation model described in the "Discussion" section are equivalent in terms of material presented and duration to Module 6, EOAC, as delivered via SMART. Further, it was assumed that each phase outlined in the model would have a full-time instructor plus other instructional, administrative and logistical support and that 50 students would be taking each phase at any given time.

Cost analyses were divided into sections for course conversion and course execution. Costs associated with the conversion of resident materials for SMART courses were derived from a report prepared by the TRADOC Management Engineer Activity titled "Estimated Time Values [ETVs] for Training Developments" (1984). These costs are expressed in professional staff hours. Course execution costs were based generally on the cost categories defined by Knapp and Orlansky (1983). These costs are expressed in dollars. The "course" is assumed to be equivalent to one module of EOAC (two weeks of instruction totalling 66 classroom hours). It is also assumed that a software package would be available to implement SMART so software development costs are not included in any of our projections.

Table 9 lists the estimate of the number of hours it would take a branch school to duplicate the course conversion accomplished by the SMART project staff. The conversion represents a revision of existing materials rather than full scale development. For purposes of comparison, we have also used the TRADOC document on ETVs to estimate the number of hours required to develop the same program of instruction from scratch for presentation in residence using traditional instruction methods. All the individual categories and subcategories for full scale development are not

Table 9

Estimated Amount of Time for SMART Conversion

Category	Time (Hours)	% of Conversion Effort
Course Requirements Analysis		10%
Conduct Initial Review	111	
Assemble Draft Training Program Package	180	
Coordinate Draft Training Program Approval	42	
Provide Draft Training Program Implementation Assistance	102	
Course Design		4%
Select Instructional Setting	46	
Identify Learning Objective Relationship	20	
Group Learning Objectives	15	
Prepare Practical Exercise Tests	82	
Course Development		61%
Develop Draft Course Management Plan	101	
Revise Draft Course Management Plan	19	
Develop New Lesson Plan	459	
Develop New Student Aids	576	
Develop New Instructor Guide	81	
Validation - Presents Lesson	475	
Validation - Revises Lesson	325	
Proofreads Final Product	553	
CBI/Slide Conversion	812	19%
Video Tape Production *	251	6%
Total	4250	
Resident Course Development Total		11761

* Includes the hours to prepare and supervise the contract for a CBI project plus the hours spent by the ACC Project contractor to actually perform the low level CBI conversion required by the ACC Project.

shown, but have been combined to produce the single figure shown at the bottom of the table.

Projected course execution costs are shown in Table 10 with separate columns for one time and recurring costs. Each column was further subdivided into contractor and in-house sections. Actual hours the contractor spent working on the project were adjusted by cost category to eliminate research peculiar activities and to expand the projection to cover two modules and the increased student load implementation would incur. The hours were then multiplied by the contractor's average "loaded" hourly rate in dollars and the rate calculated for an in-house effort from standard pay tables and data on operating costs provided by TRADOC (ATRM-159 Report). The production, equipment, and shipping categories are the same for contractor and in-house because we have assumed that the branch school would absorb essentially the same costs experienced by the contractor.

The execution cost categories have been defined as follows: (1) Production -- reproduction of materials and preparations for shipping; (2) Equipment -- computer hardware and software; (3) Training -- training instructors, both face-to-face and online; (4) Shipping -- transporting computers and materials to students; and (5) Operating and Support -- instructor salaries, computer maintenance and communications, support communications, course management, and test and evaluation.

Cost Effectiveness

Table 11 shows course execution costs in dollars per student and dollars per student per hour of instruction. Again, an in-house / contractor range is provided for the SMART implementation. SMART costs were based on a class size of 50 and one time costs were amortized over five classes because it can be expected that course materials and equipment would be reused. The resident costs shown are based on the ATRM-159 Report.

Table 10

TRADOC SMART Execution Costs

Execution Cost	One Time $K ** (Contractor / In-House)	Recurring $K (Contractor / In-House)
Production	-----	16.8 / 16.8
Equipment	49.3 / 49.3	-----
Training	46.7 / 23.8	0.6 / 0.3
Shipping	-----	8.0 / 8.0
Operating and Support	-----	189.0 / 96.1
Totals	96.0 / 73.1	214.4 / 121.2

** It has been assumed that new training and equipment will be required after five course iterations.

Table 11

Relative Costs of RC Training Options

	Execution $/Student	$/Student/Hour
SMART	4,672 (contracted) / 2,716 (in-house)	71 / 41
Resident	5,793	88

Relative costs alone, however, are not adequate to determine the viability of SMART for RC training. Both cost and effectiveness measures (throughput and quality) were directly compared.

As was shown previously, SMART courses are comparable to resident courses with respect to quality (performance and acceptability). Hence, since execution is less expensive for SMART than for resident school, it would compare favorably on cost-effectiveness (CE) ratios based on these measures.

The critical CE ratio, however, is that concerned with throughput, since it is in this area that resident school surpasses SMART. Previously, we gave conservative estimates of SMART throughput at 64% and of resident throughput at 95%. Given a starting class size of 50, the CE ratios can be developed using the following formula:

CE = (Class Size Percent Throughput)/Cost x 100%

This ratio reflects the execution cost per student for students who actually become trained.

For SMART, CE (contracted) = 0.68 and CE (in-house) = 1.18. The resident CE = 0.82 (see Table 12). The SMART CE ranges demonstrates that SMART is at least comparable to residence in cost effectiveness at even 64% throughput. However, as has been previously stated, we feel that SMART has the potential to achieve better than 64% throughput. If this is the case, SMART will clearly exceed resident CE. Figure 16 shows that even contractor developed and conducted SMART training at 64% throughput becomes less costly than resident training after four course iterations. In this illustration, one time front-end conversion/development costs have been added to one time and recurring execution costs at the first iterations for SMART training. One time execution costs are repeated after the fifth iteration because it has been assumed that there will be a need both to train new instructors due to personnel turnover and to replace worn-out equipment. Dollar amounts for conversion/development were determined by multiplying the hourly rates previously discussed by ETV hours. An additional amount ($34.1K), equal for both "contractor" and "in-house" efforts, was added to cover the cost of computer based instruction (CBI) development. In Table 9, it was assumed

Table 12

Cost-Effectiveness Ratios

Throughput: SMART 64%
Resident 95%

Cost Effectiveness Ratios: CE (SMART in-house) $= \frac{50 \times .64}{2716} \times 100 = 1.18$

CE (SMART contracted) $= \frac{50 \times .64}{4672} \times 100 = .68$

CE (Resident) $= \frac{50 \times .95}{5793} \times 100 = .82$

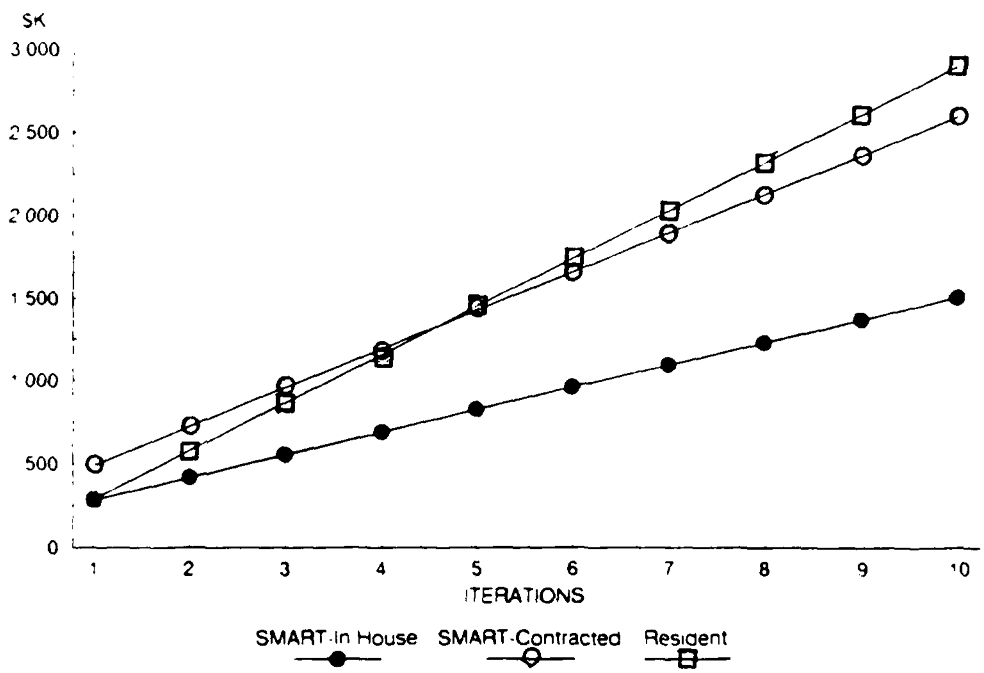

Figure 16. Implementation costs

that CBI development would be contracted out rather than conducted in-house.

Conclusions and Recommendations

In this report, it has been demonstrated that SMART courses are effective, as compared to resident programs, with respect to performance and acceptability. While SMART courses have not yet achieved the throughput seen in resident programs, their throughput does exceed that of correspondence courses, while providing the same flexibility afforded by correspondence. Indeed, SMART courses suit students' needs for flexibility of scheduling and are generally more available to a wider range of RC students than are resident programs.

Further, the cost effectiveness of contractor developed SMART programs is similar to that of resident school, in spite of the lower throughput.

SMART is very effective in meeting the needs of the RC because it can

-- overcome geographical dispersion and low density MOS training requirements by bringing students together remotely;
-- stretch training resources (instructors) by making an instructor in one location available to students in many locations;
-- accommodate civilian and personal commitments, due to its asynchronous nature; and
-- provide a means for maintaining Army contacts online.

However, SMART courses will not be successful unless certain implementation requirements are met. These include:

-- providing each student with a suitably equipped computer, preferably a portable rather than a desk top model;
-- providing well-supported, well-documented software to support communications, conferencing, and special applications;
-- giving special attention to logistical coordination, including access to telephone lines and adequate power supplies;
-- setting deadlines for completion of activities, and providing both incentives and penalties to encourage compliance;
-- being aggressive in the application of motivational techniques such as performance feedback;
-- orienting students to the nature of activities (content or process emphasis) and explicitly stating requirements;
-- scheduling the course to accommodate civilian jobs, family commitments, and other military duties;
-- using a variety of media, including both group and individual learning activities, for the presentation of instruction; and
-- providing support communications (i.e., a telephone hotline) that are available during hours when students are most likely to be working on the course.

Further details on implementation requirements can be found in "Distributed Training for the Reserve Component: Course Conversion and Implementation Guidelines" (Hahn, Harbour, Schurman, Daveline, and Wells, 1990).

Questions still remain regarding the viability of a course level implementation of SMART. Specifically, more information is needed on:

-- Staffing requirements: what mix of full- and part-time instructional and administrative support is needed to conduct a course level implementation of SMART?
-- Software interface: what are the optimal software requirements with respect to communication, delivery of instruction, and course administration? and
-- Class size: how many students can one instructor handle in a classroom setting and in a team room setting?

Based on the results found in the implementation test, SMART appears to be able to provide acceptable throughput, performance, and availability at a reasonable cost. The use of SMART for Army training should be further pursued.

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APPENDIX A

A SAMPLE SMART SESSION

SMART presents a very different milieu than the face-to-face classroom. The following descriptions are based on features found in the software implementation created for the EOAC course. They are intended only as an example of what SMART software features might look like. To illustrate this, Figure A1 shows what the SMART student sees and does during the computer session that takes place at 2030 hours on Thursday.

(A) The first thing the student sees after turning on the computer is an analog of an electronic school. This school contains "rooms" or places where various activities occur -- feedback on tests is given in the office; small group activities take place in the team room; class discussions take place in the classroom; general chit-chat takes place in the break room; self-contained lessons, such as CAIs and storyboards, are taken in the learning center; and homework assignments and tests are done in the writing center. The school metaphor serves as an aid to understanding the learning environment for the student who is moving from the known world of the face-to-face classroom to the unknown world of SMART.

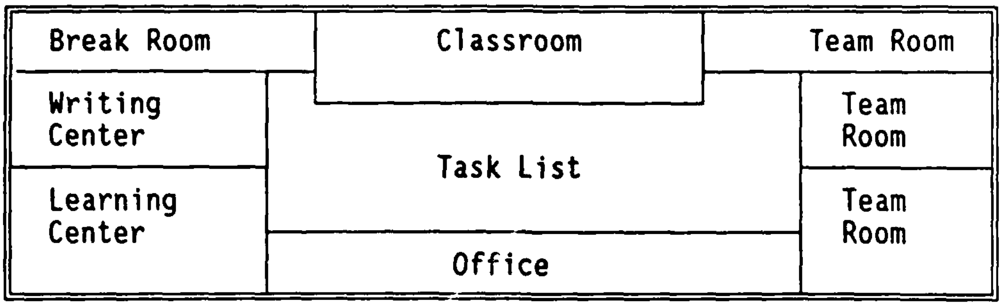
(B) The task list serves as an organizer, whereby the student selects activities to perform. In addition to selecting self-contained course requirements, such as performing a CAI, the student may elect to send or receive information to/from other students and/or the instructor. This is done by "uploading" or "downloading" to/from the host computer. The task list also serves a course management function as it keeps track of what lesson activities the student still needs to complete.

(C) A typical student would probably first elect to download information from the host computer. By downloading, answers to any questions that were posed to the instructor, messages from classmates, and feedback on any graded activities completed would be received. Only that information sent to the host computer since the student last downloaded is provided. Information is organized hierarchically by net, item, response, and date. Before continuing through our overview of the SMART session, an explanation of these concepts is in order.

A <u>net</u> is the computer equivalent of a room in the electronic school where activities take place. Information from similar types of activities are stored together in a net. For example, in Figure A1 (C), the net is the CLASSROOM. This is where discussions about technical topics take place. As can be seen from the figure, students are asking questions about course content.

An <u>item</u> is a statement or discussion about a single subject or thought. In Figure A1 (C), you will note designators such as 14:4 and 17:5. The number to the left of the colon is an item number which keys the student to the item being discussed. In the example, Item 14 is a technical

A



B

```
TASK LIST                                        STATUS
  1.  Do reading on airfields                     DONE
  2.  Do CAI on airfields                         NEED
  3.  Review roads and airfields lessons          NEED
  4.  Take roads and airfields exam               NEED

  A.  Upload to hose
  B.  Download from host
                                     Select menu option
```

C

Downloading from CLASSROOM:

Feb21/89 23:08
14:4) John Jones: Help on activity 8
When I fill out the table in step (b-2), I get a No Go for the No. 10 sieve and Gos for the rest. The tables values are 80, 15, 25, and 5. The sample values are 80, 10, 15, and 4. Where am I going wrong? I'll check back later tonight for some advice and will drive on in the meantime.

Feb.21/89 23:45
17:5) Mike Smith: I need help too
Help! I do not have a clue as to what is going on in the thickness design of each layer in the building of a road or airfield. It is not clicking as to where the thickness is coming from or how to break down each layer and know how thick it should be. I understand the first part of the problems, but not the last 2 or 3 steps. Can anyone help???

Feb22/89 00:08
17:6) Joan Black: Here is a little help John
John, I can't help you a lot but if you use half of the months at 31 days and half at 30 you will come up with the correct answer.

Figure A1. Sample SMART session

discussion on Road Design, while Item 17 is a technical discussion on Airfield Design.

In the designators, the number to the right of the colon is a response number. A <u>response</u> is a comment about an item or another response. Responses are displayed in the order in which they are received, as indicated by the date and time stamps shown in Figure A1 (C).

The excerpts shown in Figure A1 (C) are transcripts from a real class, with only the names changed. They represent a portion of the student-to-student dialog taking place in about a one-hour period on a given evening. Several features of the transcript are noteworthy:

- The time stamps -- as was stated previously, SMART students do most of their course work during evening and weekend hours; the time stamps reflect Eastern time; "John Jones," a student who lives in Maryland, was working on the course at 11 p.m.;

- Organization -- because students are working asynchronously, even though responses 17:5 and 17:6 follow one another chronologically they do not follow logically; response 17:6 obviously is a response to a comment posted at some time previous to 17:5; further, not all students are working on the same course topics, as evidenced by activity in two items which do not refer to the same content areas; the result of this is that students must devote time and effort to organizing downloaded information into a logical (i.e., by item) sequence, usually by printing the information and binding it in a notebook; and

- Peer learning -- these items are being used by the students to ask and answer technical questions; while the instructor would have the ultimate responsibility of answering technical questions, other resources are available to the student with a question, as evidenced by "Joan Black's" response; unlike the face-to-face environment, where it is usual for the instructor to speak and the student to listen, computer conferencing affords equal air time to all and students are free to respond to one another in any public discussion.

Returning to the discussion of how a SMART session appears to the student, let us examine a snapshot of a the student's remaining tasks, as shown in Figure A2.

(A) The SMART software prompts the student for comments on items and responses that were just read. The software transforms the student's entry into language understandable by the conferencing system, so the student does not have to learn the peculiarities of a particular conferencing system. Finally, the SMART software returns the student to the task list when downloading and responding are completed.

A

Respond to item? Y/N
Item number? 14
Enter your response:

> John, what CBR are you using for a table value? Remember to downgrade the CBR and recheck it.

MORE/RETURN TO TASK LIST

B

DESIGN OF AIRFIELDS 1

This set of lessons will introduce you to the design of airfields. Please proceed through the lessons in alphabetical order.

A. Introduction
B. Design Steps

Select menu option

.
.

STEPS IN DETERMINING RUNWAY LENGTH 130

The TGR in Table 3 was determined at 59 degrees F, at an altitude of 0 feet, and with an effective gradient of less than 2%. If any of these three factors are different for the airfield being designed, correction factors will have to be developed.

Press Enter for more

.
.

STEPS IN DETERMINING RUNWAY LENGTH 135

Which one of the following is NOT a correction factor that may have to be applied to the TGR?

A. temperature
B. altitude
C. effective gradient
D. wind strength

Enter the selection of your choice: D Correct!

Figure A2. Continuation of sample SMART session

(B) The next task selected by the student is performing a CAI lesson. The SMART software automatically finds and displays the correct lesson for the student. As the student moves through the lesson, information is presented and questions are asked. When the student answers a question, immediate feedback is given as to whether or not the answer was correct.

Serving the SMART function as a course management system, the SMART software stores the student's answers and automatically sends them to the instructor when the student next selects the upload function from the task list. In fact, selecting the upload function causes all newly created data, such as the responses shown in Figure A2 (A) and answers to CAIs and quizzes, to be automatically transmitted to the host computer in the format required by the conferencing system. Typically, the student would upload after completing all other computer-mediated activities during a particular session.

APPENDIX B

SMART SOFTWARE IMPLEMENTATION

Because Phases 1 and 2 differed with respect to the availability of group interaction, slightly different versions of the electronic classroom were presented via SMART for the two phases. Recall from the previous discussion, that the functions of SMART are to provide a communication system, a combination of delivery media, and a course management system.

The course management function was fully supported in both phases. In both phases, a task list was used to guide student access to the learning activities. This task list provided a display of personal progress through the course for each student. An office function was also available in both phases; this provided a place where the student could obtain feedback on grades and course progress.

To a lesser extent, a variety of media were also supported in both phases. Both phases fully supported paper-based and locally delivered electronic media, such as CAIs and storyboards, through the learning center. Phase 1 was more limited than Phase 2, however, in that no synchronous or asynchronous group activities were supported.

This point ties in to the main area in which SMART functions were not fully supported in Phase 1 -- communication. In both phases, homework and other written assignments to be sent privately to the instructor were performed in the writing center. In Phase 1, however, the many-to-many communication supported by ACC was curtailed such that students could only hold private discussions with the instructor or another student. No group communication was possible.

The following paragraphs detail the features of SMART that were unique to each phase.

Phase 1

Figure B1 (A) shows the analog of the electronic school displayed for the students during Phase 1. In this school, content-related private discussions between a student and the instructor took place in the classroom. One-on-one conversations on any topic could take place between students or between a student and the instructor in the break room.

Students entered the school via the task list, shown as Figure B1 (B). Note that all activities on the task list are individual content-oriented activities. At the outset of the phase, students were not given deadlines for topic completion. Rather, they were told to work at least the minimum eight hours per week and to complete the phase as rapidly as they could.

Phase 2

In Phase 2, many-to-many communications were supported via the INTERACT feature shown in Figure B2 (A). This feature allowed for group

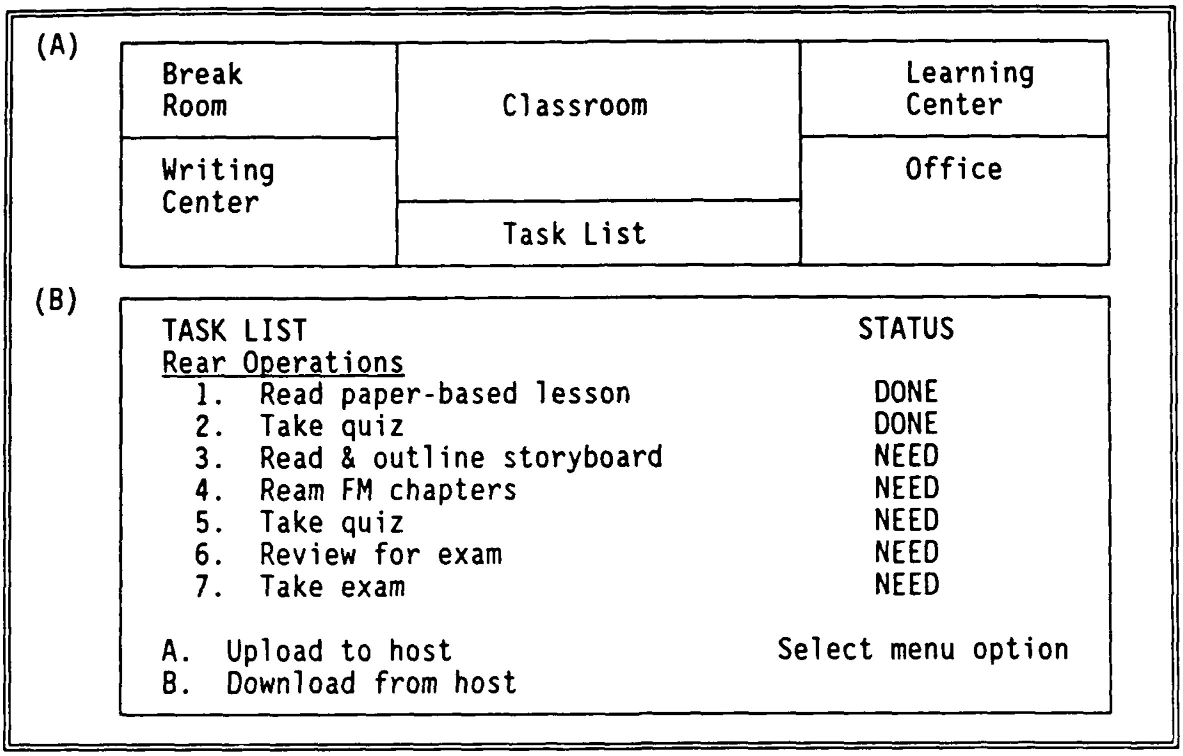


Figure B1. Phase 1 electronic school

communication in the break room (on any topic), class room (on content-related subjects), and in the team rooms (on group exercises). Interaction in the team rooms was semi-private in that it was limited to team members and the instructors, and could not be viewed by class members who were not part of the team.

Different forms of private communication were also supported. One-on-one discussions could be held between students in the mail room, a student and the instructor in the instructor help room, and a student and the team leader in the team leader help room.

As shown in Figure B2 (B), the task list for Phase 2 directed students to both individual and group content-oriented activities. At the outset of this phase, students were given due-dates for each topic, based on the eight hour per week time requirement.

Phase 3

In Phase 3, all features present in Phase 2 were available to the students. However, the learning center was only used by students needing to review previously taught content -- no new instruction was presented in the learning center. Further, the task list was not presented electronically. Rather, to avoid costly software changes, students were sent a paper syllabus which detailed the tasks to be performed. The information provided

(A)

Writing Room	INTERACT Classroom Break Room Team Rooms	Learning Center
Mail Room		Office
Team Leader Help Room	Task List	Instructor Help Room

(B)

TASK LIST	STATUS
<u>Flexible Pavements</u>	
1. Read & outline storyboard	DONE
2. Take quiz	DONE
3. Perform paper-based exercise	NEED
4. Take quiz	NEED
5. Solve a team exercise	NEED
6. Review for exam	NEED
7. Take exam	NEED
A. Upload to host	Select menu option
B. Download from host	

Figure B2. Phase 2 electronic school

on the syllabus was the same as that provided electronically, except that students had to manually chart their progress through the activities.